Columbia/Snake Rivers Temperature TMDL

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Columbia/Snake Mainstem Temperature Total Maximum Daily Load Executive Summary

1. Background

In October 2000, the States of Oregon, Washington and Idaho signed a Memorandum of Understanding with the U.S. Environmental Protection Agency-Region 10 (EPA) that committed EPA to take the lead for technical development of a Columbia/Snake Mainstem Temperature Total Maximum Daily Load (TMDL) and the three states to support of TMDL development. TMDL development is generally a state responsibility, but considering the interstate and international nature of the waters, EPA's technical expertise in the modeling effort, and EPA's Tribal Trust responsibilities, EPA agreed to take responsibility for the technical development of this TMDL. Subsequently, Oregon and Washington requested by letter that EPA issue this TMDL for the Columbia- Snake River Basin within the States of Oregon and Washington. Idaho has committed to simultaneously issue the TMDL for waters within the State of Idaho.

This Columbia/Snake Mainstem Temperature TMDL is necessitated by inclusion of both rivers on the Clean Water Act (CWA) Section 303(d) lists of impaired waters of all three states due to water temperatures that exceed state water quality standards (WQS). EPA and the States, in coordination with the 14 Columbia River Tribal Governments, developed this Draft Columbia/Snake Mainstem Temperature Total Maximum Daily Load Specifically, this draft TMDL was developed under the guidance of a technical steering committee consisting of EPA, the three States and interested Tribes. The Federal Columbia River Power System (FCRPS) Action Agencies (Bureau of Reclamation, U.S. Army Corps of Engineers, and Bonneville Power Administration) all participated in monthly meetings which began in 2001. It is expected that when this draft is released to the public, it will go through a 90 day public comment period. After considering public comments and making changes to the proposed TMDL as appropriate, EPA will issue a Final Columbia/Snake Mainstem Temperature TMDL.

This draft Columbia and Lower Snake Total Maximum Daily Load is one of many other Total Maximum Daily Load (TMDL) efforts currently underway throughout the Region and the Nation, as a tool to improve water quality. The result of this TMDL effort and others is not the establishment of water quality goals. Rather water quality goals for the Columbia and Lower Snake mainstem and other rivers and streams have already been established by state and tribal water quality standards.

2. Purpose of the Draft Columbia/Snake Mainstem Temperature TMDL

As required by Section 303(d)(1)(C) of the Clean Water Act (CWA), this draft TMDL has been calculated at a level necessary to implement the applicable water quality standards, which in this case were promulgated by the States of Washington, Oregon, and Idaho, the Spokane Tribe of Indians and EPA (for the Confederated Tribes of the Colville Reservation). The applicable water quality standards are based on the water temperature that would exist in the absence of human activities in the rivers. The water temperature that would occur in the absence of human activity is not quantified in the standards. Therefore, the specific water temperature targets, the magnitude of temperature problems in the river and the level of temperature improvements in the rivers are not known. Therefore, the purpose of this TMDL is to:

1. Define the specific temperature targets in accordance with State and tribal water quality standards;
$ quantify the temperature problem in the main stems; and
$ determine the level of improvement in water temperature needed to meet water quality standards.

The TMDL analysis uses models in order to calculate water temperature in the absence of human activities. That is, dams and point sources of pollution are mathematically removed from the river. Those model results then become the basis for the loading capacity and allocations presented in the draft TMDL. They are not an endorsement of removal of dam structures; rather, they are necessary to apply the water quality standards.

TMDLs are not self-implementing. Nor do they impose any binding legal requirements under federal law. EPA encourages States to develop plans to implement TMDLs. Except in the case of NPDES-regulated point sources, implementation of TMDLs and the allocations they contain is a question of state law.

3. BACKGROUND ON TEMPERATURE ISSUES IN THE COLUMBIA AND SNAKE MAINSTEM
Interest in temperature in the Columbia and Snake River Mainstem peaked during development of the 2000 FCRPS Biological Opinion (2000 FCRPS Bio-Op) by the National Marine Fisheries Service. Many involved in this 2000 FCRPS Bio-Op process believed that elevated temperatures play a significant role and salmon survival and temperature improvements are critical to salmon recovery. Others believe that temperature in the mainstems had not changed significantly from natural conditions.

Ongoing and Future Temperature Improvement Efforts - While the States of Oregon, Idaho and Washington are taking the lead for TMDL implementation planning, they rely heavily on the FCRPS Action Agencies in developing practical steps to be taken to reduce temperature. In fact, development of improvement alternatives requires a system wide evaluation of the FCRPS and the Columbia/Snake River system. Improvements in temperature resulting from operation of the river system will rely heavily on regional, national and even international forums. Because of the complicated policy and technical issues incumbent on implementation planning, in this case, it could be a lengthy process.

The FCRPS has been active in planning and implementing measures to improve water temperature in the Columbia and Snake River main stems. The Bonneville Power Administration is financing sub-basin planning all over the Columbia Basin to improve salmon habitat, including temperature in the tributaries to the Columbia and Snake Rivers. The Corps of

Engineers, through a collaborative approach with fish and water quality managers, has operated Dworshak Dam for the last four years to discharge cooler water to improve temperature in the Lower Snake River. The Bureau of Reclamation has been active in working with EPA in development of the draft TMDL to ensure that there is an adequate understanding of the operation of Grand Coulee Dam and the Columbia Basin Irrigation Project and to brain storm improvement measures that can be evaluated to determine if they are feasible and will have a beneficial effect on water temperature downstream of Grand Coulee while not causing impairment of temperature upstream of the dam in Lake Roosevelt. To date, implementation planning has not included water quality modeling that can be used to evaluate the effects of improvement alternatives at specific dams and sites along the river. In 2002, as part of implementing a 2000 FCRPS Bio-Op Reasonable Prudent Alternative, the FCRPS agencies began an effort to assess monitoring and modeling needs. Working with National Marine Fisheries Service (NOAA Fisheries), Fish and Wildlife Service, EPA, the States and some Tribes, the FCRPS agencies developed an interagency committee that is evaluating monitoring and modeling efforts on the rivers. That committee, chaired by the Corps and NOAA Fisheries, will determine appropriate water quality models and the monitoring necessary to support those models. That committee has been very active and has resulted in intensive monitoring efforts in 2002, including monitoring of temperature in fish passage facilities.

Continued cooperation of the federal agencies, the states and tribes will ensure that the implementation planning results in a balanced strategy that (1) considers ecological needs above and below Grand Coulee, (2) achieves the Congressionally authorized purpose of the FCRPS, and (3) is technically feasible and economically achievable.

3. The Role of this Draft TMDL and the Overall Water Quality Improvement Process

The overall process for improving water quality as laid out in the Clean Water Act involves several major steps:

- the desired water quality is defined via state and tribal water quality standards.
- waters of a lower quality than the water quality standards are identified on state and tribal Clean Water Act Section 303(d) lists (also known as "Lists of Impaired Waterbodies").
- a Total Maximum Daily Load (TMDL) is established for waters on the 303(d) list.
- implementation plans are developed by the state to achieve the TMDL.
- in some cases, a balance must be struck between the TMDL and the water quality standards if the standards cannot feasibly be met under Section 40 CFR 131.10(g).
- the TMDL is implemented through the NPDES Permit Program, State Water Quality Standards Certification Program, States Non-point Source Management Program and other appropriate mechanisms.

During implementation planning , it may become clear that there are no feasible improvement alternatives that will achieve the TMDL. In these cases, the TMDL and the water quality standards may have to be adjusted to achieve the highest levels of water quality that are feasible. Often the TMDL and the implementation plan are developed together and there may even be iterative revision of the two until a workable mix is achieved. The EPA water quality standards regulations provide for situations where water quality standards cannot be attained. The regulations specifically address dams. At 40 CFR 131.10(g) the regulations say:

> "States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because: ....(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use."

The regulations also address the concept of economic feasibility at 40 CFR 131.10(g)(6):

> "Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact."

In the case of the draft Columbia and Snake River Mainstem Temperature TMDL, development of the TMDL and implementation planning are now taking place at the same time, though no determination has been made as to whether feasible alternatives exist that will ensure attainment of water quality standards. A Draft Implementation Plan will be available concurrently with this Draft TMDL for public review.

In actuality, implementation can occur simultaneously with the planning processes and in this case a great deal of work is being done to improve temperature in the Columbia and Snakes rivers as previously described. The whole water quality improvement process outlined above, including developing the TMDL, will be an iterative process. As the FCRPS agencies continue to work toward temperature improvements, develop water quality models and collect water quality data, the Final TMDL may updated. The underlying water quality standards may also need to be revised to strike a balance between competing ecological needs and competing uses and values of the river system. If it is not feasible to achieve the Final TMDL without sacrificing ecological needs upstream of Grand Coulee or the other uses of the river system, the water quality standards can be revised. Thereafter, the TMDL can be revised to achieve the new standards.

4. DESCRIPTION OF WATERBODY, POLLUTANT OF CONCERN, AND POLLUTANT SOURCES

This draft Total Maximum Daily Load (TMDL) addresses water temperature in the mainstem segments of the Columbia River from the Canadian Border (River Mile 745) to the Pacific Ocean and the Snake River from its confluence with the Salmon River (River Mile 188) to its confluence with the Columbia River. The States of Oregon and Washington and the U.S. Environmental Protection Agency (EPA) have listed multiple segments of both mainstem reaches on their federal Clean Water Act (CWA) 303(d) lists due to water temperatures that exceed state water quality standards (WQS). The entire reaches of both rivers are considered impaired for water temperature. EPA is establishing this TMDL for waters within the States of Oregon and Washington and within the Reservations of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. The Idaho Department of Environmental Quality will simultaneously issue the TMDL for waters within the jurisdiction of the State of Idaho.

Water temperature can be elevated above natural conditions by a number of human activities. The primary sources of elevated temperatures in the Columbia and Snake Rivers are point sources, nonpoint sources, and dams. Point sources discharge thermal energy directly to the river. Nonpoint sources such as agricultural run off discharge to the rivers primarily via irrigation canals and tributaries. Dams alter river temperature by changing the flow regime, stream geometry, current velocity and flood plain interactions of the river.

The effects of point sources and tributaries (nonpoint sources) on cross sectional average water temperatures in the mainstems are for the most part quite small. The point sources can cause temperature plumes in the near-field but they do not result in measurable increases to the cross-sectional average temperature of the main stems. That is, the cumulative impact of all the point sources is less than 0.14 EC when temperature criteria are exceeded in the river. Some of the dams, however, do cause measurable changes in the cross-sectional average temperature of the mainstems. They increase the cross-sectional average temperature and they extend the period of time during which the water temperature exceeds numeric temperature criteria. The impact to water temperature of the dams ranges from very small at Rock Island where the maximum impact is about 0.07 EC to the impact of Grand Coulee which is as high as 6.0 EC in the late fall. Eight of the 15 dams have maximum impacts to temperature of over 0.5 EC.

5. DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS AND NUMERIC TARGETS

The Water Quality Standards (WQS) for temperature on the Columbia and Snake Rivers are quite complex. The three States and two Tribes with EPA-approved or promulgated standards have adopted a variety of numeric and narrative criteria for temperature in the segments of the Columbia/Snake mainstems within their jurisdictions. A common component in all of the standards is a provision to account for times when natural water temperatures in the rivers exceed numeric water quality criteria. Generally, when this occurs, the standards allow small incremental increases to the natural temperatures. Washington WQS, which apply to all of the TMDL project area except the upper 12 miles of the Snake River reach, also restrict incremental increases in temperature when the natural temperature is below numeric criteria. The TMDL is based on the most stringent standards that apply on the rivers reach by reach. Table S-1 summarizes the WQS standards that are the basis for this TMDL.

Table S-1: Summary of Water Quality Standards that Apply to the Columbia and Snake Rivers

Columbia River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Canadian Border to Grand Coulee Dam	16 EC DM	Natural + 23/(T+5)	Natural + 0.3 EC
Grand Coulee Dam to Chief Joseph Dam	16 EC DM	Natural + 23/(T+5)	Natural + 0.3 EC
Chief Joseph Dam to Priest Rapids Dam	18 EC DM	Natural + 28/(T+7)	Natural + 0.3 EC
Priest Rapids Dam to Oregon Border	20 EC DM	Natural + 34/(T+9)	Natural + 0.3 EC
Oregon Border to mouth	12.8/20 EC DM	Natural + 1.1 EC	Natural + 0.14EC
Snake River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Salmon River to OR/WA Border	12.8/17.8 EC 7DADM	Up to Criterion	Natural + 0.14 EC

OR/WA Border to ID/WA Border	20 EC DM	Natural + 1.1 EC	Natural + 0.3 EC
ID/WA Border to Mouth	20 EC DM	Natural + 34/(T+9)	Natural + 0.3 EC

T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.
DM = daily maximum temperature.
7DADM = seven day average of the daily maximum temperatures.

Development of the target temperatures for the TMDL depends on an understanding of natural temperature. A mathematical water quality model, RBM-10, was used to simulate temperature conditions in the mainstems of the Columbia and Snake Rivers in the absence of human activity in the mainstems. The simulations utilize existing flow and temperature in the tributaries and at the TMDL boundaries. These simulated temperatures are an approximation of natural conditions because they do not account for possible impacts from altered water temperature and flow regimes outside the TMDL project area. To maintain the distinction from purely natural temperatures, these simulated temperatures are referred to as site potential temperatures. This draft TMDL is based on the site potential temperatures; the temperatures that are estimated to occur in the absence of human activity in the mainstems.

The site potential temperatures in the mainstems vary considerably throughout the year, from year to year, and longitudinally along the rivers. To account for the temporal variation, the site potential temperatures are simulated using a thirty year data record and the target temperatures for the TMDL are expressed as thirty year mean temperatures for every day of the year. To account for the spatial variation, the rivers are divided into 21 longitudinal reaches with a TMDL Target Site at the down river end of each reach.

The mathematical model, RBM-10, has been used to evaluate cumulative impacts of upstream temperature impacts on downstream segments of the TMDL. This analysis indicates that elevating temperatures of upstream segments to the degree allowed under the WQS (Table S-1) would result in exceedances of WQS in downstream segments. As a result, the target temperatures in the lower reach of the Columbia River drive the upstream allocations for this TMDL. Therefore, the target temperatures of each reach above the Oregon/Washington Border are lower than those indicated by Table S-1. The targets at each upper reach are lowered enough to ensure that the target temperature in the downstream reach are achieved. Figure S-1 illustrates the existing temperature and the TMDL target temperature at the John Day target site.

6. APPLICATION OF THE TARGET TEMPERATURES

The target temperatures for this TMDL are expressed as daily cross sectional average temperatures. The cross sectional average temperature is representative of the free flowing river because the free flowing river was generally well mixed. The target temperature must be achieved as a daily cross sectional average in the impounded river but also throughout the width and depth of the thalweg, in critical fish habitat and in fish ladders and holding facilities.

Loading Capacity - The loading capacity is expressed as temperature rather than as thermal load. The regulations governing TMDL development provide for the expression of TMDLs as "either mass per time, toxicity, or other appropriate measure" (40CFR130.2(h)). Temperature is an appropriate measure in this TMDL because dams play a major role in altering the temperature regime of the river but they do not discharge water bearing a thermal load to the river. Dams alter the temperature regime of the river by altering the stream geometry and current velocity upstream of the dam. Expressing the loading capacity and allocations as temperatures addresses a potential concern that flow in the river changes frequently due to river management objectives which can change thermal load without improving temperature. In this TMDL, the loading capacity is the daily target temperature at River Mile 42 of the Columbia River as depicted in Figure 5-1 and in Appendix B.

Pollutant Allocations (see Table S-2) - The underlying philosophy used to establish this TMDL was to allocate available heat capacity to the smallest sources first and then move incrementally up the list of sources from smaller to larger until the available capacity is fully allocated. That is, allocate existing heat load to as many sources as possible. This philosophy arises from the fact that there is insufficient capacity to provide the larger sources any meaningful relief since the total capacity to be allocated is only 0.14 EC most of the year. Therefore, the TMDL first allocates sufficient loads to account for existing discharges from individual NPDES permittees and 20 MW at each target site to account for general NPDES permittees. Any future growth will have to be part of the 20 MW allocated to general permits. The TMDL then allocates remaining capacity to account for as many of the dams as possible beginning with the dams with the smallest effect on temperature.

The analysis of NPDES point sources in the watershed indicates that the cumulative increase of temperature from point sources to be "de minimus" in comparison to the effects of the dams and never in and of itself results in exceedance of water quality standards. Even if this TMDL were to allocate the site potential temperature to each point source (ie., a wasteload equal to meeting water quality standards at the end of the discharge pipe), the applicable water quality standards would not be attained in the waterbody because of the temperature increases caused by the dams. Further, temperature reductions needed by the dams to achieve water quality standards would not change measurably. At the same time however, EPA recognizes that discharged heat may have local effects even at very small quantities, and as such, should be limited to the extent practicable. Taking these two considerations into account, this TMDL therefore provides a cumulative wasteload allocation applicable to all NPDES facilities in the mainstems that never exceeds 0.14 EC whenever site potential temperature is greater than the water quality criteria. That is, the cumulative effects of all the NPDES point sources is never measurable when the rivers exceed water quality criteria. EPA believes that the wasteload allocations in this TMDL are reasonable in light of the following factors.

2. The NPDES point sources, in the aggregate, contribute less than 0.14 EC to the total temperature within each reach when temperature exceeds water quality criteria;

3. Limiting the point source discharges to site potential temperatures will have no measurable effect on water quality and reducing them beyond the levels contemplated by the cumulative wasteload allocation is not necessary to achieve water quality standards;
4. The majority of the temperature increases (as much as 6 EC) are caused by the larger dams: therefore, water quality standards cannot be achieved under Clean Water Act authorities, therefore water quality improvement must be accomplished through federal, state, private, local and even, conceivably, international mechanisms.

The load available for allocation is the temperature increment over the natural or site potential temperature allowed under the WQS. For example, in the Lower Columbia, this increment is 0.14 EC when numeric criteria are exceeded and 1.1 EC the rest of the time. Some of this temperature increment is consumed by the allocations to the point sources as wasteload allocations (WLA). In the WLA, the load each point source can discharge to the river is expressed as megawatts (MW). There are 108 Point Sources with individual NPDES permits in this TMDL. All but 11 of these point sources have only a minimal effect on mainstem temperatures (defined for the purpose of this TMDL as less than 0.014 EC). These 97 smaller point sources are included in group allocations for each reach. The 11 larger point source dischargers receive individual allocations.

General Permits - EPA, Oregon and Washington have issued 27 general NPDES permits. Currently 16 of them have a total of 96 permittees that discharge to the Columbia or Snake Rivers. The contribution to temperature from the sources covered by the general permits is minimal; especially when compared to the temperature loads from large point sources and the impacts of the dams. An additional 20 megawatts is added to each group allocation to account for these sources.

Tributaries - Since the site potential simulations incorporate existing tributary temperatures, none of the temperature increment is allocated to tributaries. All tributaries are allocated their existing loads.
Dams - The temperature increment remaining to be allocated after allocation to the point sources is very small and therefore, the temperature increase allocated to the 15 dams is also very small. Wells, Rocky Reach, Rock Island, Priest Rapids and The Dalles dams have very small effects on water temperature. They are provided allocations that accounts for the small effects that they currently have. The other dams receive no allocation during the time of the year that water quality criteria are exceeded and a small uniform allocation (0.12 EC) when criteria are not exceeded.

Margin of Safety - Implicit margins of safety have been built into the TMDL. For point sources the WLA is based on reasonable worst case discharges. Further, the wasteload allocation for point sources does not vary with flow. It achieves water quality standards at the 7Q10 **(need to define)** low flow, thereby providing a margin of safety when flows are greater than the 7Q10. For dams, the use of daily average temperatures (as opposed to maximum temperatures only) is a conservative application of the WQS provisions regarding natural temperature conditions.

Seasonal Variation - The water quality standards for temperature, temperature itself and the effects of human activities on temperature all vary seasonally during the year. In the winter and spring, water quality standards are not exceeded, and therefore the waters of the Columbia and Snake rivers are not impaired for temperature from human activities within the main stems. In the late summer and fall, water quality standards are exceeded and the site potential temperatures exceed the water quality criteria, requiring TMDL allocations for temperature that ensure temperature doesn't exceed site potential temperature + 0.14 EC. In the late fall and early winter water quality standards are exceeded but the site potential is less than water quality criteria requiring TMDL allocations that ensure temperatures don't exceed site potential + 1.1 EC. The seasonality of the TMDL is summarized as follows:

February 6 through June 30 - no allocations required;
July 1 through October 31 - allocations to achieve site potential Temperature + 0.14 EC;
November 1 through February 5 - allocations to achieve site potential Temperature + 1.1 EC.

Future Growth - A small portion of the available temperature increases has been allocated to future growth in the group allocations. Twenty MW of heat energy have been added to each group above that needed by the dischargers in the group.

7. MONITORING PLAN - Long term, system wide effectiveness of TMDL implementation activities can be assessed by monitoring mainstem river temperatures at the target sites. Over the long term, if implementation is adequate, the daily mean temperatures at the target site should equal the 30 year mean target temperatures at those sites. Individual years may exceed those temperatures because of natural variation.

Short term monitoring for compliance with WLAs will be accomplished through effluent monitoring by the point sources. For individual dams, one option for short term monitoring is to evaluate the temperature difference between successive dams. The TMDL includes curves showing the temperature differences for existing conditions and for the conditions of the implemented TMDL. Effectiveness of TMDL implementation within individual impoundments can be determined by comparison of actual temperature differences between dams to the TMDL curves.

8. INFORMATION SHARING AND PUBLIC PARTICIPATION

Extensive public involvement activities, organized by the inter-agency TMDL Coordination Team have occurred for this TMDL over the past three years. Activities included informational meetings throughout the Columbia Basin, information and document access to the Columbia/Snake Mainstem TMDL website, fact sheets, coordination meetings, individual meetings with interested groups, nine public workshops, and numerous conference presentations. The Western Governors' Association also provided public involvement assistance. Public involvement efforts will continue until the TMDL is finalized. Public meetings with the opportunity for formal public comment will be held during the draft TMDL comment period.

9. IMPLEMENTATION PLANS

Implementation of the TMDL is entirely a State responsibility. Pursuant to respective specific state responsibilities, the States of Oregon, Washington, and Idaho have taken the lead for the development of an implementation plan working with interested tribes focused on the identification of feasible management options for improving temperature. States have developed a Summary Implementation Strategy (attached to this Draft TMDL) which identifies short term, mid term and long term implementation actions The short term actions are generally consistent with the temperature Reasonable and Prudent Alternatives (actions to avoid jeopardy under the Endangered Species Act) identified in the December 2000 Federal Columbia River Power System Biological Opinion. The mid-term and long action actions include system-wide actions that could improve water temperature in the long term.

The Summary Implementation Plan has been developed in a collaborative process with the FCRPS Action Agencies. A key element of this Plan is the commitment to evaluate the need to revise water quality standards upon which the TMDL is based should the temperature improvements contemplated by those standards prove to be unattainable.

Implementation is proposed to be coordinated through a TMDL Implementation Workgroup led by the states which retains authorities of participating agencies.

Table S-2: Summary of the Columbia/Snake River TMDL, showing gross allocations for each river reach and individual wasteload or load allocations

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
COLUMBIA RIVER FACILITIES					
International Border to Grand Coulee	**.001 EC**	**0.121 EC**	**0.001 EC**	**0.0 EC**	**0.12 EC**
Group			21.37 MW		
Grand Coulee Dam				0.0 EC	0.12 EC
Grand Coulee to Chief Joseph	**.001 EC**	**0.121 EC**	**0.001 EC**	**0.0 EC**	**0.12 EC**
Group			24.53 MW		
Chief Joseph Dam				0.0 EC	0.12 EC
Chief Joseph to Wells	**.111 EC**	**0.121 EC**	**0.001 EC**	**0.11 EC**	**0.12 EC**
Group			23.78 MW		
Wells Dam				0.11 EC	0.12 EC
Wells to Rocky Reach	**.1315 EC**	**0.0915 EC**	**0.0015 EC**	**0.13 EC**	**0.09 EC**
Group			28.01 MW		
Rocky Reach Dam				0.13 EC	0.09 EC
Rocky Reach to Rock Island	**0.053 EC**	**0.0703 EC**	**0.003 EC**	**0.05 EC**	**0.07 EC**
Group			90.80 MW		
Rock Island Dam				0.05 EC	0.07 EC

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
Rock Island to Wanapum	**.001 EC**	**0.121 EC**	**0.001 EC**	**0.0 EC**	**0.12 EC**
Group			20.46 MW		
Wanapum Dam				0.0 EC	0.12 EC
Wanapum to Priest Rapids	**.281 EC**	**0.181 EC**	**0.001 EC**	**0.28 EC**	**0.18 EC**
Group			20.0 MW		
Priest Rapids Dam				0.28 EC	0.18 EC
Priest Rapids to McNary	**.052 EC**	**0.172 EC**	**0.052 EC**	**0.0 EC**	**0.12 EC**
Group			244.13 MW		
Agrium Bowles Road			206.8 MW		
Agrium Game Farm Road			384.5 MW		
Boise Cascade Walulla			284.2 MW		
McNary Dam				0.0 EC	0.12 EC
McNary to John Day	**0.002 EC**	**0.122 EC**	**0.002 EC**	**0.0 EC**	**0.12 EC**
Group			63.18 MW		
John Day Dam				0.0 EC	0.12 EC

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
John Day to The Dalles	**0.1478 EC**	**0.1108 EC**	**0.0008 EC**	**0.147 EC**	**0.11 EC**
Group			20.73 MW		
The Dalles Dam				0.147 EC	0.11 EC
The Dalles to Bonneville	**.004 EC**	**0.124 EC**	**0.004 EC**	**0.0 EC**	**0.12 EC**
Group			99.07 MW		
Bonneville Dam				0.0 EC	0.12 EC
Bonneville to River Mile 112	**.02 EC**	**0.02 EC**	**.02EC**	**0.0 EC**	**0.0 EC**
Group			164.04 MW		
Fort James Camas			337.8 MW		
River Mile 112 to River Mile 95	**0.026 EC**	**0.026 EC**	**.026 EC**	**0.0 EC**	**0.0 EC**
Group			926.3 MW		
River Mile 95 to River Mile 72	**0.026 EC**	**0.026 EC**	**0.026 EC**	**0.0 EC**	**0.0 EC**
Group			42.84 MW		
Boise/ St.Helens			219.56 MW		
Coastal St. Helens			365.09 MW		

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
River Mile 72 to River Mile 42	**0.046 EC**	**0.046 EC**	**0.046 EC**	**0.0 EC**	**0.0 EC**
Group			235.85 MW		
Longview Fiber			455.4 MW		
Weyerhouser Longview			545.43 MW		
GP Wauna			301.71 MW		
River Mile 42 to River Mile 4	**0.001 EC**	**0.001 EC**	**0.001 EC**	**0.0 EC**	**0.0 EC**
Group			46.79		
River Mile 4 to River Mile 0	**0.001 EC**	**0.001 EC**	**0.001 EC**	**0.0 EC**	0.0 EC
Group			26.28		

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
SNAKE RIVER FACILITIES					
Salmon River to River Mile 138	**0.06 EC**	**0.06 EC**	**0.06 EC**	**0.0 EC**	**0.0 EC**
Group			**30.28 MW**		
Potlatch			298.76 MW		
River Mile 138 to Lower Granite	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			20.0 MW		
Lower Granite Dam				0.0 EC	0.12 EC
Lower Granite to Little Goose	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			20.02 MW		
Little Goose Dam				0.0 EC	0.12 EC
Little Goose to Lower Monumental	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			21.39 MW		
Lower Monumental Dam				0.0 EC	0.12 EC
Lower Monumental to Ice Harbor	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			20.004 MW		
Ice Harbor Dam				0.0 EC	0.12 EC

Ice Harbor to River Mile 0	**0.003** EC	**0.003** EC	**0.003** EC	**0.0** EC	**0.0** EC
Group			20.004 MW		
River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
SNAKE RIVER FACILITIES					
Salmon River to River Mile 138	**0.06** EC	**0.06** EC	**0.06** EC	**0.0** EC	**0.0** EC
Group			**30.28 MW**		
Potlatch			298.76 MW		
River Mile 138 to Lower Granite	**0.003** EC	**0.123** EC	**0.003** EC	**0.0** EC	**0.12** EC
Group			20.0 MW		
Lower Granite Dam				0.0 EC	0.12 EC
Lower Granite to Little Goose	**0.003** EC	**0.123** EC	**0.003** EC	**0.0** EC	**0.12** EC
Group			20.02 MW		
Little Goose Dam				0.0 EC	0.12 EC
Little Goose to Lower Monumental	**0.003** EC	**0.123** EC	**0.003** EC	**0.0** EC	**0.12** EC
Group			21.39 MW		
Lower Monumental Dam				0.0 EC	0.12 EC
Lower Monumental to Ice Harbor	**0.003** EC	**0.123** EC	**0.003** EC	**0.0** EC	**0.12** EC
Group			20.004 MW		

Ice Harbor Dam				0.0 EC	0.12 EC
Ice Harbor to River Mile 0	**0.003 EC**	**0.003 EC**	**0.003 EC**	**0.0 EC**	**0.0 EC**
Group			20.004 MW		

1.0 Introduction

1.1 The Role of this TMDL and the Overall Water Quality Improvement Process

The overall process for improving water quality as laid out in the Clean Water Act involves several steps. First, the desired water quality is defined via state water quality standards. Second, waters of a lower quality than the water quality standards are identified on state 303(d) lists (also known as "Lists of Impaired Waterbodies"). Third, a Total Maximum Daily Load (TMDL) is established for waters on the 303(d) list. Fourth, implementation plans are developed by the state to achieve the TMDL. Fifth, in some cases, a balance must be struck between the TMDL and the water quality standards. During implementation planning, it may become clear that there are no feasible improvement alternatives that will achieve the TMDL. In these cases, the TMDL and the water quality standards may have to be adjusted to achieve the highest levels of water quality that are feasible. Finally, the TMDL is implemented through the NPDES Permit Program, State Water Quality Standards Certification Program, the States Non-point Source Management Program and other appropriate mechanisms.

Often the TMDL and the implementation plan are developed together and there may even be iterative manipulation of the two until a workable mix is achieved. In the case of the main stems temperature TMDL, the two have been kept some what separated. Interest in temperature in the main stems peaked during development of the 2000 Federal Columbia River Power System (FCRPS) Biological Opinion by the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS). Many believed that elevated temperatures played a role in the reduction of salmon runs, while others believed that temperature in the main stems had not changed significantly from natural conditions. Further, the water quality standards do not establish a clear target for temperature and require considerable analysis. So it wasn't clear if there was a temperature problem, how severe it was or what was causing it. Implementation planning to improve water temperature could be very costly, especially for the federal and public utility district dams on the rivers. Therefore, it is prudent to verify that a problem exists and to quantify the extent of the problem before investing a great deal. Essentially, the role of this TMDL in improving temperature in the Columbia/Snake River main stems is to clarify these issues. The purpose of this TMDL is to:

1. define the temperature targets;
2. quantify the temperature problem on the main stems;
3. determine the level of improvement needed.

The TMDL, therefore, uses water quality modeling to determine the specific water temperature targets for the main stems on the basis of state water quality standards. The water quality standards require identification of what the temperatures would be in the absence of human activities on the main stems. Having determined the temperature regime required by the state water quality standards, the TMDL evaluates whether the existing main stems achieve those target temperature regimes and quantifies the contributions of existing human activities to temperature increases in the river. This TMDL finds that temperature does exceed the target temperature regimes required by state water quality standards so it goes on to quantify the improvement needed and allocate heat loads to the various human activities on the main stems that, if achieved, will result in compliance with the target temperatures.

The next step in improving temperature in the main stems is to develop the implementation plan. That is, determine what specific operational changes at the dams and point sources of heat along the rivers can be implemented to achieve the TMDL and ultimately achieve water quality standards. In other words, what feasible alternatives are available to improve temperature. The TMDL identifies some of the dams on the main stems to be the major contributors to temperature increases in the main stems. Implementation planning to achieve temperature improvements at dams will be technically complicated, costly and generally outside Clean Water Act authorities. The federal dams were specifically authorized by Congress for specific purposes such as flood control, power generation, irrigation and navigation. Decisions on the feasibility of alternatives to improve temperature at these facilities will have to consider the ability of the FCRPS to continue achieving the purposes established by Congress, the technical feasibility of the alternatives and the economic feasibility of the alternatives.

The states take the lead for TMDL implementation planning but they will rely heavily on the Federal Agencies that administer and operate the FCRPS. In fact, development of improvement alternatives will require a sytstem wide evaluation of the FCRPS and the Columbia/Snake River system. Improvements in temperature resulting from operation of the river system will rely heavily on regional, national and even international forums. Because of the complicated policy and technical issues incumbent on implementation planning, in this case, it could be a lengthy process.

However, that is not to say that the FCRPS has been inactive in planning and implementing measures to improve water temperature in the Columbia and Snake River main stems. The Bonneville Power Administration is financing sub-basin planning all over the Columbia Basin to improve salmon habitat, including temperature in the tributaries to the Columbia and Snake Rivers. The Corps of Engineers has operated Dworshak Dam for the last three years to discharge cooler water to improve temperature in the lower Snake River. Every year, the Corps works with EPA, NMFS and the states and tribes to refine and fine tune it's approach to operating the Dworshak Dam. Two major limitations on implementation planning have been the lack of data to adequately characterize water temperature and the lack of water quality modeling that can evaluate the effects of improvement alternatives at specific dams and site along the river. In 2002, the FCRPS agencies began an effort to address these limitations. Working with NMFS, FWS, EPA, the states and the tribes, the FCRPS agencies developed an interagency committee that is evaluating monitoring and modeling efforts on the rivers. That committee, chaired by the Corps and NMFS, will determine appropriate water quality models and the monitoring necessary to support those models. That committee has been very active and has resulted in intensive monitoring efforts in 2002, including monitoring of temperature in fish passage facilities. The Bureau of Reclamation has been active in working with EPA in development of the TMDL to ensure that there is an adequate understanding of the operation of Grand Coulee Dam and the Columbia Basin Irrigation Project and to brain storm improvement measures that can be evaluated to determine if they are feasible and will have a beneficial effect on water temperature downstream of Grand Coulee while not causing impairment of temperature upstream of the dam in Lake Roosevelt.

Continued cooperation of the federal agencies, the states and tribes will ensure that the implementation planning results in a balanced strategy that considers ecological needs above and below Grand Coulee and achievement of the Congressionally authorized purpose of the FCRPS and is technically feasible and economically achievable. Step 5 of the water quality improvement process is to alter the TMDL and the water quality standards, as appropriate, to strike this balance between competing ecological needs and competing uses and values of the river system. If it is not feasible to achieve the TMDL without sacrificing ecological needs upstream of Grand Coulee or the other uses of the river system, the water quality standards can be amended and the TMDL revised to achieve the new standards.

The EPA water quality standards regulations provide for situations where water quality standards cannot be attained. The regulations specifically address dams. At 40 CFR 131.10(g) the regulations say “States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because: ....(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use.” The regulations also address te concept of economic feasibility at 40 CFR 131.10(g)(6): “Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.”

Sequentially, the final step in the improvement process is actual implementation of the measures to improve water quality. In actuality, implementation can occur simultaneously with the planning processes and in this case a great deal of work is being done to improve temperature in the Columbia and Snakes rivers as described above. The whole water quality improvement process outlined above, including the TMDL will be an iterative process. As the FCRPS agencies continue to work toward temperature improvements, develop water quality models and collect water quality data, the TMDL may updated.

1.2 Scope of this TMDL

The scope of this TMDL is water temperature in the main stem segments of the Columbia River from the Canadian Border (River Mile 745) to the Pacific Ocean and the Snake River from its confluence with the Salmon River (River Mile 188) to its confluence with the Columbia River (see Figure 1-1). Table 1-1 summarizes the portions of the two rivers listed as impaired for temperature pursuant to Section 303(d) of the Clean Water Act. EPA listed the Snake River from the Salmon River to the Washington/Idaho Border on the Idaho 1998 Section 303(d) list (EPA, 2001). Oregon included the entire Oregon portions of the Snake and Columbia rivers on its 1998 Section 303(d) list (Oregon DEQ, 1998). Washington included 26 different segments of the two rivers on its 1998 Section 303 list (Washington DOE, 1998). In a letter dated September 4, 2001, Washington clarified that "...much or all of the mainstem Columbia and Snake Rivers violate water quality standards for temperature..." and that the entire lengths of the Columbia and Snake rivers should be addressed in the temperature TMDL (Washington DOE, 2001). This TMDL addresses dams, point sources and non-point sources of thermal loading to the main stems themselves. There are 15 dams, as well as 108 point sources regulated by individual National Pollutant Discharge Elimination System (NPDES) permits, on the two main stems addressed by this TMDL. There are also 27 general NPDES permits that currently regulate 96 facilities on the Snake and Columbia rivers. The thermal loadings from non-point sources enter the main stems primarily through tributaries and irrigation return flows. There are 193 tributaries including seven significant irrigation flows addressed in this TMDL.

1.3 Legal Authority

Under authority of the Clean Water Act, 33 U.S.C. § 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the U.S. Environmental Protection Agency is establishing a Total Maximum Daily Load (TMDL) for temperature in the main stems of the Columbia River from the Canadian Border to the Pacific Ocean and the Snake River from its confluence with the Salmon River to its confluence with the Columbia River. EPA is establishing the TMDL for waters within the states of Washington and Oregon and waters within the reservations of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. At this time, the Idaho Department of Environmental Quality is anticipating simultaneously issuing the TMDL for waters within the jurisdiction of the State of Idaho.

The States of Oregon, Washington and Idaho worked with EPA in coordination with the thirteen tribes of the Columbia Basin to develop this inter-jurisdictional TMDL for the Columbia and Snake River main stems. The Oregon Department of Environmental Quality requested in writing (Oregon DEQ, 2001) that EPA establish the TMDL in the State of Oregon. The Department cited the interstate nature of the waterway, EPA's development of the temperature model, RBM 10, and the Department's lack of resources as the reasons for its request. The request was made pursuant to Section X of the TMDL Memorandum of Agreement between EPA and the Department of Environmental Quality dated February 1, 2000.

Idaho:

HUC	Waterbody	Boundaries	Pollutant
17060103	Snake River	Salmon River to Washington State Line	Temperature

Oregon:

Basin	Waterbody	Boundaries	Pollutant
Lower Columbia	Columbia River	Mouth to Tenasillahe Island	Temperature
Lower Columbia	Columbia River	Tenasillahe Island to Willamette River	Temperature
Lower Columbia	Columbia River	Willamette River to Bonneville Dam	Temperature
Middle Columbia	Columbia River	Bonneville Dam to The Dalles Dam	Temperature

Middle Columbia	Columbia River	The Dalles Dam to John Day Dam	Temperature
Middle Columbia	Columbia River	John Day Dam to McNary Dam	Temperature
Middle Columbia	Columbia River	McNary Dam to Washington Border	Temperature
Middle Snake	Snake River	Washington Border to Hell's Canyon Dam	Temperature

Washington:

Water Resource Inventory Area Name	Water Resource Inventory Area Number	Waterbody	Pollutant	Number of Segments
Grays-Elokoman	25	Columbia River	Temperature	3
Lewis	27	Columbia River	Temperature	2

Salmon-Washougal	28	Columbia River	Temperature	6
Klickitat	30	Columbia River	Temperature	3
Rock-Glade	31	Columbia River	Temperature	2
Moses Coulee	44	Columbia River	Temperature	1
Chelan	47	Columbia River	Temperature	1
Lower Snake	33	Snake River	Temperature	4
Snake River	35	Snake River	Temperature	4

Similarly, the Washington Department of Ecology requested by letter (Washington DOE, 2001) that EPA establish the Columbia/Snake Main Stem Temperature TMDL in Washington. The Department also cited the inter-jurisdictional nature of the waterways, EPA's work on the TMDL and the Department's lack of resources as the reasons for its request. The request was made pursuant to Section 13 of the TMDL Memorandum of Agreement between the Department of Ecology and EPA dated October 29, 1997.

EPA has authority under section 303(d)(2) of the Clean Water Act (CWA) to approve or disapprove TMDLs submitted by the states and tribes and to establish its own TMDLs in the event that it disapproves a state or tribal submission. EPA also has authority under section 303(d)(2) to establish TMDLs in response to an explicit state request. EPA’s exercise of authority to establish TMDLs in response to a state’s request is consistent with the larger purpose of section 303(d)(2) – to ensure the timely establishment of TMDLs – and it honors the primary responsibility imputed by Congress to the states. In addition, when the TMDL focuses on interstate waters, EPA’s involvement can facilitate the resolution of complex cross-jurisdictional problems that might be difficult for an individual state, acting alone, to resolve. For similar reasons, EPA has authority to establish TMDLs on behalf of tribes that have not been authorized to establish TMDLs under section 518(e) of the CWA.

1.4 Coordination with States and Tribes

EPA invited consultation with 14 Sovereign Tribes of the Columbia River Basin in a February 11, 2002, letter from L. John Iani, EPA Region 10 Regional Administrator, to each Tribal chair. Copies were also provided to the Columbia River Inter-Tribal Fish Commission. The letter recognized Tribal rights and the federal government responsibility to tribal governments and offered to provide the Tribes and tribal staff an opportunity for meaningful involvement in EPA’s final action on this TMDL effort. EPA offered to meet individually with Tribes on a government-to-government basis. In response to this invitation EPA has met with a number of the tribal governments. EPA has also been providing direct technical assistance to the Colville Confederated Tribes and the Spokane Tribe.

EPA has been requested by Tribal representatives to address historic preservation and to explain how cultural resources issues would be addressed by this TMDL. EPA is proposing in this preliminary draft that the State and Tribal Implementation plans address the National Historic Preservation Act. EPA will continue to coordinate and consult with the Tribes to integrate historic preservation and cultural concerns into actions stemming from this TMDL.

EPA signed a Memorandum of Agreement (MOA) with the states of Oregon, Idaho and Washington in August 2001. This MOA described the mutual relationship between the states and EPA Region 10 to complete dissolved gas and temperature TMDLs for the mainstem Columbia and Snake Rivers. The MOA detailed the conceptual approach to the TMDL effort, the roles of the MOA signatories, expected roles of the cooperating agencies, resources, and schedule.

Beginning in February 2001 and continuing until present, EPA, states and tribal staff met on a monthly basis to plan the development of the temperature TMDL effort, agree on technical issues and plan outreach and coordination efforts. In 2001, Federal Action Agencies (U.S. Army

Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration) and industry representatives were invited to participate in these monthly meetings as well.

2.0 Applicable Water Quality Standards

2.1 General

Three states and two Indian tribes have WQS standards promulgated pursuant to section 303(c) of the CWA that apply to the Columbia and Snake Rivers: Idaho, Oregon, Washington, Confederated Tribes of the Colville Reservation, and Spokane Tribe of Indians. The WQS for each state and tribe for the portions of the Columbia and Snake Rivers subject to this TMDL are summarized below:

2.2 Idaho

The WQS for Idaho are established in the Idaho Administrative Code, IDAPA 16.01.02, "Water Quality Standards and Wastewater Treatment Requirements." Section 130.02 establishes the designated aquatic life uses of the Snake River between the Washington Border (river mile 138) and the Salmon River (river mile 188) as cold water. Section 100.01.a defines cold water as "water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species." Section 250.02.b establishes the water quality criteria for temperature for the cold water aquatic life use designation as "Water temperature of twenty-two (22) ^{o}C or less with a maximum daily average of no greater than nineteen (19) ^{o}C."

Section 070.06 discusses natural background conditions: "Where natural background conditions from natural surface or groundwater sources exceed any applicable water quality criteria as determined by the Department, that background level shall become the applicable site-specific water quality criteria. Natural background means any physical, chemical, biological, or radiological condition existing in a water body due only to non-human sources. Natural background shall be established according to protocols established or approved by the Department consistent with 40 CFR 131.11. The Department may require additional or continuing monitoring of natural conditions."

2.3 Oregon

The WQS for Oregon are established in the Oregon Administrative Rules, OAR 340-041-0001 to OAR 340-041-00975, "State-Wide Water Quality Management Plan; Beneficial Uses, Policies, Standards, and Treatment Criteria for Oregon." The Snake River in Oregon from the OR/WA Border at river mile 176 to the Salmon River at river mile 188 is included in this TMDL. The WQS for that portion of the river are included in the section for the Grande Ronde Basin (OAR 340-041-0722). The beneficial uses most sensitive to temperature in that reach are "Salmonid Fish Rearing" and "Salmonid Fish Spawning." The temperature criteria applicable to the reach are, in relevant part:

"To accomplish the goals identified in OAR 340-041-0120(11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-41-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:
(i) In a basin for which salmonid rearing is a designated beneficial use, and in which surface water temperatures exceed 64.0 ^{o}F (17.8 ^{o}C);
(ii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55 ^{o}F (12.8 ^{o}C)....
(vi) In stream segments containing federally list Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;" (OAR 340-041-0725 (2)(b)(A).

The period of the year designated by the Oregon Department of Environmental Quality for the protection of salmonid spawning, egg incubation, and fry emergence in the Snake River is October 1 through June 30 (Oregon DEQ, 1998).

The numeric temperature criteria are established for the seven-day moving average of the daily maximum temperatures. If there is insufficient data to establish a seven-day average of maximum temperatures, the numeric criterion is applied as an instantaneous maximum (OAR 340-041-0006 (54)). A measurable surface water increase is defined as 0.25 ^{o}F (OAR 340-041-0006 (55)) . Anthropogenic is defined to mean that which results from human activity (OAR 340-041-0006 (56)).

The segment of the Columbia River which serves as the OR/WA border is included in this TMDL and subject to OR WQS. It stretches from the mouth of the river to river mile 309. The temperature sensitive beneficial uses vary from segment to segment along that reach as shown in Table 2-1.

Table 2-1: Oregon designated uses along the Columbia River

Basin/Columbia River Miles	Anadromous Fish Passage	Salmonid Fish Rearing	Salmonid Fish Spawning	Shad and Sturgeon Spawning/Rearing
Lower Columbia / 0-86	X	X		
Willamette / 86-120	X	X	X	
Sandy / 120-147	X	X		
Hood / 147-203	X	X	X	X
Deschutes /203-218	X	X		
John Day / 218-247	X	X	X	
Umatilla / 247-309	X	Trout	Trout	

The temperature criterion applicable to the Columbia River in Oregon is in relevant part:

"To accomplish the goals identified in OAR 340-041-0120(11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-41-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed: ...

(ii) In the Columbia River or its associated sloughs and channels from the mouth to river mile 309 when surface water temperatures exceed 68.0 ^{o}F (20.0 ^{o}C)"
(iii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55 ^{o}F (12.8 ^{o}C)....
(vi) In stream segments containing federally list Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;" (OAR 340-041-0205(2)(b)(A).

The period of the year designated by the Oregon Department of Environmental Quality for the protection of salmonid spawning, egg incubation, and fry emergence in the Columbia River is October 1 through May 31 (Oregon DEQ, 1998).

Salmonid spawning occurs in the lower Columbia River upstream of river mile 112. Chum salmon are known to spawn around the Ives Island complex down stream of Bonneville Dam and in the vicinity of Interstate 205. They spawn in November and December and the eggs incubate until April. Lower river brights (Chinook) are also known to spawn in the Ives Island area starting about mid-October. Therefore, the water quality criteria for the lower Columbia are as follows:

$ mouth to river mile 112
all year - 20.0 EC

$ river mile 112 to rm 146
October 1- May 31 - 12.8 EC
June 1 - September 30- 20.0 EC

2.4 Washington

The WQS for Washington are established in the Washington Administrative Code, Chapter 173-201A WAC, "Water Quality Standards for Surface Waters of the State of Washington." Waters of the state are categorized in the Water Quality Standards into classes based on the character of the uses of each water body. The designated uses of the Columbia and Snake rivers most sensitive to temperature are salmonid migration, rearing, spawning and harvesting; and other fish migration, rearing, spawning and harvesting (WAC 173-201A-030). The most protected class on the Columbia and Snake rivers is "AA" or 'extraordinary' and this applies only to Lake Roosevelt. The rest of the river is grouped into class "A" or 'excellent' (WAC 173-201A-130). Under each of these classes, the temperature standard is applicable at any time of day or night. It applies toward fish protection in all portions of the rivers, including fish passage facilities and fish ladders within the dam structures.

Each class of water is assigned a daily maximum numeric temperature criterion. For class "AA" waters it is 16 EC and for class "A" waters it is 18 EC (WAC 173-201A-030). However, for the Columbia River below Priest Rapids dam and for the entire Snake River, a special condition applies which is two degrees higher, 20 ^{o}C (WAC 173-201A-130).

The Washington standards also include narrative requirements associated with natural conditions. "Natural Conditions" for temperature means water temperatures as they are best assessed to have existed before any human-caused pollution or alterations. If the Snake or Columbia Rivers are found to have a natural condition higher than the criterion, no additional temperature pollution can be added that will result in raising that natural temperature more than 0.3 ^{o}C. The wording of this portion of the standard indicates that the 0.3 ^{o}C increment is a constraint on the cumulative impact of all dischargers (WAC 173-201A-020).

There are also constraints on incremental temperature increases when existing temperatures are below the numeric criterion In some segments these allowable increases are expressed as formulas to be applied to individual sources, while in others the allowable increases are expressed as a maximum value not to be exceeded by cumulative impacts. The numeric temperature criteria and narratives establishing the allowable incremental temperature increases, applicable to the Snake and Columbia Rivers in Washington, are summarized in Table 2-2.

Table 2-2: Washington Water Quality Standards along the Columbia and Snake Rivers

Water Body	***Criteria***
Columbia Main Stem from the coast to the Oregon/Washington Border	"Temperature shall not exceed 20 ^{o}C (68 F) due to human activities. When natural conditions exceed 20 ^{o}C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 ^{o}C (0.5 F) nor shall such temperature increases, at any time exceed 0.3 ^{o}C (0.5 F) due to a single source or 1.1 ^{o}C (2.0 F) due to all such activities combined." WAC 173-201A-130(20)
Columbia Main Stem Priest Rapids Dam to OR/WA Border	"Temperature shall not exceed 20 ^{o}C (68 F) due to human activities. When natural conditions exceed 20 ^{o}C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 ^{o}C (0.5 F) nor shall such temperature increases, at any time exceed T=34/(T+9)." WAC 173-201A-130(21)
Columbia Main Stem Priest Rapids to Grand Coulee	"Temperature shall not exceed 18 ^{o}C (64.4 F) due to human activities. When natural conditions exceed 18 ^{o}C (64.4 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 ^{o}C (0.5 F). Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T+7). Incremental increases resulting from nonpoint source activities shall not exceed 2.8 ^{o}C (5.4 F)." WAC 173-201A-130(21) and WAC 173-201A-030(2)

Columbia Main Stem Above Grand Coulee	"Temperature shall not exceed 16 °C (60.8 F) due to human activities. When natural conditions exceed 16 °C (60.8 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F). Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=23/(T+5). Incremental increases resulting from nonpoint source activities shall not exceed 2.8 °C (5.4 F)." WAC 173-201A-130(22) and WAC 173-201A-030(1)
Snake Main Stem from the Washington/Oregon Border to the Clearwater River.	"Temperature shall not exceed 20 °C (68 F) due to human activities. When natural conditions exceed 20 °C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F) nor shall such temperature increases, at any time exceed 0.3 °C (0.5 F) due to a single source or 1.1 °C (2.0 F) due to all such activities combined." WAC 173-201A-130(98)(b)
Snake Main Stem from the Clearwater River to the Columbia River.	"Temperature shall not exceed 20 °C (68 F) due to human activities. When natural conditions exceed 20 °C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C (0.5 F) nor shall such temperature increases, at any time exceed t=34/(T+9)." WAC 173-201A-130(98)(a)

t = the maximum permissible temperature increase measured at a mixing zone boundary
T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

2.5 Confederated Tribes of the Colville Reservation

The WQS for the Confederated Tribes of the Colville Reservation were promulgated by EPA at 40 CFR 131.135. These standards apply to the Columbia River from the northern boundary of the reservation downstream to Wells Dam. The Columbia River is designated as "Class I (Extraordinary)" from the Northern Border of the Reservation to Chief Joseph Dam and "Class II (Excellent)" from Chief Joseph Dam to Wells Dam. The designated uses most sensitive to temperature are "Fish and shellfish: Salmonid migration, rearing, spawning and harvesting: other fish migration, rearing, spawning and harvesting." The temperature criterion for Class I waters is:

> "(D) Temperature - shall not exceed 16.0 °C due to human activities. Temperature increases shall not, at any time, exceed t=23/(T+5).
> (1) When natural conditions exceed 16.0 °C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3 °C.

(2) For purposes hereof, "t" represents the permissive temperature change across the dilution zone: and "T" represents the highest existing temperature in this water classification outside of any dilution zone.
(3) Provided that temperature increase resulting from nonpoint source activities shall not exceed 2.8 ^{o}C, and the maximum water temperature shall not exceed 16.3 ^{o}C."

The temperature criterion for Class II waters is:

"Temperature - shall not exceed 18.0 ^{o}C due to human activities. Temperature increases shall not, at any time, exceed t=28/(T+7).
(1) When natural conditions exceed 18.0 ^{o}C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3 ^{o}C.
(2) For purposes hereof, "t" represents the permissive temperature change across the dilution zone: and "T" represents the highest existing temperature in this water classification outside of any dilution zone.
(3) Provided that temperature increase resulting from nonpoint source activities shall not exceed 2.8 ^{o}C, and the maximum water temperature shall not exceed 18.3 ^{o}C."

2.6 Spokane Tribe of Indians

The WQS for the Spokane Tribe were adopted by the tribe on March 7, 2003, and approved by EPA on April 22, 2003. These standards apply to the Columbia River from the northern boundary of the reservation downstream to the confluence with the Spokane River. The Columbia River is designated as "Class AA (Extraordinary)". The temperature criterion for Class AA waters is:

"Water used for spawning or rearing by naturalized populations of indigenous salmon or trout. Not to exceed a 7-day average of the daily maximum temperature values greater than 16.5 deg C from June 1 to September 1. Not to exceed a 7-day average of the daily maximum temperature values greater than 13.5 deg C between September 1 and October 1 and between April 1 and June 1, and not to exceed 11 deg C from October 1 to April 1; with no single daily maximum temperature exceeding 18.5 deg C.

Exception for Non-Anadromous Rainbow and Redband Trout. In waters where the only salmonid present is non-anadromous form of naturalized rainbow or redband trout. Temperatures from June 1 to September 1 may be allowed to reach a 7-day average of the daily maximum temperatures of 18.5 deg C."

For the Columbia River mainstem above Grand Coulee Dam, the only salmonid present would be a non-anadromous form. Therefore, the second half of the criterion applies for this TMDL. In addition, the Spokane WQS include a general provision regarding natural conditions:

"Whenever the natural conditions of any specific surface waters of the Reservation are of a lower quality than the criteria assigned to waters typical of that class, the Department may determine that the natural conditions shall constitute the water quality criteria."

2.6 Applicable Water Quality Standards for this TMDL

The goal of this TMDL is to achieve all of the promulgated WQS for temperature in the Columbia and Snake River mainstems. Since the standards vary according to river location and jurisdiction, the development of the TMDL begins with a reach-by-reach review of overlapping state and tribal standards to determine the most stringent standard for each reach. Table 2-3 summarizes the most stringent water quality standards for the Columbia and Snake Rivers for purposes of this TMDL.

EPA believes it is reasonable to apply the most stringent temperature water quality standard for each reach because this is an interstate TMDL and the Columbia and Snake Rivers form borders between the affected states. This approach is the only way EPA has identified to ensure that all temperature water quality standards are met for the affected segments. Based on the record available to EPA at this time, EPA is concerned that developing a TMDL targeted at the less stringent temperature standards for a particular reach would not assure achievement of the more stringent standards also applicable to the reach, because it appears that temperature loadings delivered at the border by the state with the less stringent standards – i.e., the "background" loadings – would make it difficult, if not impossible, for the neighboring state to achieve its temperature water quality standards.

Moreover, as a legal matter, EPA is authorized to consider downstream water quality standards (including those in other states),when establishing or approving a TMDL. The U.S. Supreme Court in Arkansas v. Oklahoma, 503 U.S. 91 (1992), held that EPA has the authority to impose NPDES permit limitations and conditions based on downstream water standards. At issue in that case was EPA's issuance of an NPDES permit to an Arkansas facility that imposed conditions derived from the downstream state's water quality standards. (The court declined to address the issue of whether the statute required consideration of downstream standards because it found that EPA's assertion of authority was reasonable.) Noting that "the statute clearly does not limit the EPA's authority to mandate such compliance," the Court held, "The regulations relied on by the EPA were a perfectly reasonable exercise of the Agency's statutory discretion. The application of state water quality standards in the interstate context is wholly consistent with the Act's broad purpose 'to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.' 33 U.S.C. § 1251(a). Moreover, as noted above, § 301(b)(1)(C) expressly identifies the achievement of state water quality standards as one of the Act's central objectives. The Agency's regulations conditioning NPDES permits are a well-tailored means of achieving this goal." The regulations considered by the court, 40 C.F.R. § 122.4(d), provide, "No permit shall be issued . . . [w]hen the imposition of conditions cannot ensure compliance with the applicable water quality requirements of all affected States."

The principle articulated with the Supreme Court in the NPDES permitting context applies with equal force to TMDLs, which are an important tool for implementing section 301(b)(1)(C) with respect to point source discharges. Washington, Oregon and EPA, as the permitting authority in Idaho and for Tribal waters, are required to consider water quality standards in downstream segments (including those in other states) when establishing NPDES permit limitations and conditions for sources whose discharges ultimately flow to the downstream segments. See 40 C.F.R. § 122.4(d). For point sources discharging to waters flowing into the Columbia and Snake Rivers, those permit limitations need to be "consistent with" the assumptions of the TMDL for those rivers, irrespective of state boundaries. See 40 C.F.R. § 122.44(d)(1)(vii)(B). Therefore, in order to reconcile applicable permit regulations, it follows that EPA, when establishing a TMDL for upstream waters, may take into account the downstream water quality standards that would apply, under 40 C.F.R. § 122.4(d), to point source discharges covered by the TMDL. When a water forms a border, as here, each state is potentially downstream of the other for purposes of EPA's regulations.

Table 2-3: Summary of Water Quality Standards that Apply to the Columbia and Snake Rivers

Columbia River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Canadian Border to Grand Coulee Dam	16 EC DM	Natural + 23/(T+5)	Natural + 0.3 EC
Grand Coulee Dam to Chief Joseph Dam	16 EC DM	Natural + 23/(T+5)	Natural + 0.3 EC
Chief Joseph Dam to Priest Rapids Dam	18 EC DM	Natural + 28/(T+7)	Natural + 0.3 EC
Priest Rapids Dam to Oregon Border	20 EC DM	Natural + 34/(T+9)	Natural + 0.3 EC
Oregon Border to mouth	12.8/20 EC DM	Natural + 1.1 EC	Natural + 0.14EC

Snake River Reach	Criterion	Natural Temp < Criterion	Natural Temp > Criterion
Salmon River to OR/WA Border	12.8/17.8 EC 7DADM	Up to Criterion	Natural + 0.14 EC
OR/WA Border to ID/WA Border	20 EC DM	Natural + 1.1 EC	Natural + 0.3 EC
ID/WA Border to Mouth	20 EC DM	Natural + 34/(T+9)	Natural + 0.3 EC

T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.
DM = daily maximum temperature.
7DADM = seven day average of the daily maximum temperatures.

2.7 Antidegradation

All four jurisdictions contain an antidegradation policy in their WQS. Generally, the antidegradation policies apply to waters that are of a higher quality than the water quality criteria. In these waters the existing water quality must be protected and pollution that would reduce the existing water quality is not allowed. All four jurisdictions do provide exceptions to this policy when certain conditions apply. The antidegradation provisions are important to this TMDL because much of the year, the temperature of the main stems is below the numeric criteria.

2.8 Mixing Zones

All four jurisdictions have mixing zone provisions in their WQS. The Colville standards refer to them as dilution zones. Mixing and dilution zones are the areas in the vicinity of point source outfalls where mixing results in the dilution of the effluent with the receiving water.

Water quality criteria may be exceeded in the mixing or dilution zone. All four jurisdictions have restrictions on the size and characteristics of mixing or dilution zones.

3.0 Technical Considerations

3.1 Mathematical Modeling

The WQS that apply to the Columbia River require derivation of the specific target temperatures for the TMDL based on natural temperatures in the river (see Table 2-3). Natural temperature is considered to be the water temperature that would exist in the river in the absence of any human-caused pollution or alterations. This definition applies to all human activities: those that effect the river temperature directly such as point sources of warm water or dams and impoundments; and those that effect river temperature indirectly such as development in the water shed and air pollution that results in climate change.

The Columbia River was first dammed in 1933 and the Snake River, its principal tributary was first dammed in the 19th century. Since the 19th century the number of dams in the TMDL study area has grown to 15, and the watershed has been extensively developed for forestry, agriculture, mining and domestic and industrial uses. Such human activities in the watershed of a river generally lead to altered water temperatures in the river. There is little temperature data available for the free flowing Columbia and Snake rivers that would reflect natural temperature prior to the advent of these human sources of thermal energy in the watershed. Therefore, it is necessary to use a mathematical model to simulate natural temperatures in order to derive the specific temperature targets for the TMDL.

RBM 10 is a peer-reviewed, one-dimensional, energy budget model developed to simulate temperature in the Columbia River (Yearsley et al, 2001). It simulates daily cross sectional average temperatures under conditions of gradually varied flow. Models of this type have been used to assess water temperature in the Columbia River system for a number of important environmental analyses. The Federal Water Pollution Control Administration (Yearsley, 1969) developed and applied a one-dimensional thermal energy budget model to the Columbia River as part of the Columbia River Thermal Effects Study. The Bonneville Power Administration et al. (1994) used HEC-5Q, a one dimensional water quality model, to provide the temperature assessment for the System Operation Review, and Normandeau Associates (1999) used a one-dimensional model to assess water quality conditions in the Lower Snake River for the U.S. Army Corps of Engineers. RBM 10 was used by the Corps of Engineers for the temperature assessment in the "Lower Snake River Juvenile Salmon Migration Feasibility Report and Environmental Impact Statement" (Corps, 2002).

RBM 10 requires information on the river system and weather. Necessary river system information includes topology, geometry (cross-sectional area and width), mainstem inflows and temperatures at the model boundaries, and tributary and point source flows and temperatures. In order to simulate temperature in the absence of human intervention, geometry information is needed for the original, free flowing river. Necessary weather information is cloud cover, dry bulb air temperature; wind speed, vapor pressure of the air and atmospheric pressure. A thirty year data record consisting of the needed weather and flow information was constructed for the period from 1970 through 1999. Stream geometry for the un-impounded and existing river was compiled from the Columbia River Thermal Effects Study (Yearsley, 1969), information from the Walla Walla District, U.S. Army Corps of Engineers and from NOAA navigation charts (Yearsley et al, 2001). Using this record, thirty years of river temperatures were simulated for both the Columbia and Snake rivers under impounded and free flowing conditions. To simulate free flowing conditions, the dams and point sources are mathematically removed in order to approximate natural temperature conditions within the TMDL study area. In the remainder of this report, simulations of impounded conditions are often referred to as “the impounded river” while simulations of free flowing conditions are referred to as the “free flowing” or “site potential” river. A number of model scenarios were used to evaluate temperature impacts and develop this TMDL (see Table 3-1).

The source code, input data, assumptions, and documentation of the RBM10 are part of the administrative record for this TMDL and will be made available to interested parties upon request during the public comment period. EPA will respond to any comments on the model that pertain to its use in the development of this TMDL.

Table 3-1: Model Scenarios Used in Development of TMDL

Scenario	**Model Setup**	**Outputs**	**Findings**
1. Site Potential Temperature	Daily Time Step Un-impounded River Existing tributary/boundary inflows No point sources	Daily site potential temperatures for 30-year period (10,950 values) Mean daily site potential temperatures (365 values)	Temperatures exceed numeric criteria (e.g., 20 deg C in lower Columbia) in absence of human activity on mainstems

2. Actual Temperature	Daily Time Step Impounded River Existing tributary/boundary inflows All point sources	Daily actual temperatures for 30-year period (10,950 values) Mean daily actual temperatures (365 values)	Actual temperatures are higher than site potential temperatures in late summer/fall (e.g., 3.5 deg C warmer at John Day dam)
3. Point Source Cumulative Impacts	Daily Time Step Impounded River Existing tributary/boundary inflows Point Sources - 2 scenarios Scenario 1: No point sources Scenario 2: All point sources	Maximum daily temperature impacts for 30-year period (scenario 2 - scenario 1)	Maximum, cumulative point source impact less than 0.14 deg C when site potential exceeds 20 deg C. At other times, impact exceeds 0.14 but is far below allowable impact of 1.1 deg C.
4. Individual Dam Impacts	Daily Time Step Impounded River Existing tributary/boundary inflows No point sources Dams - 16 scenarios - Scenario 1: all dams included Scenarios 2-16: one dam removed & effects evaluated	Daily impacts for 30-year record (scenario1 - scenario 2-16) Mean daily impacts for 30-year record	Maximum temperature increases due to dams range from 0.1 deg C (Rock Island) to 6.2 deg C (Grand Coulee)

5. TMDL Target Temperatures	Daily Time Step Un-impounded River Existing tributary/boundary inflows All point sources Dams - 2 seasons: Aug-Oct: Actual effects from 5 dams (Wells, Rocky Reach, Rock Island, Priest Rapids, and The Dalles). No effect from other 10 dams Nov-Feb: Actual effects from 5 dams (Wells, Rocky Reach, Rock Island, Priest Rapids, and The Dalles), plus 0.12 deg C effect from remaining dams	Mean daily target temperatures for 30-year record	Fully allocates allowable temperature increment, based on compliance with standards at RM42
6. Diurnal Fluctuation	Hourly time step Impounded and Un-impounded Existing tributary/boundary inflows All point sources All dams (for impounded scenario)	Hourly average temperatures for 30-year record, impounded and un-impounded	Greater diurnal fluctuations in un-impounded river than impounded river
Scenario	**Model Setup**	**Outputs**	**Findings**

1. Site Potential Temperature	Daily Time Step Un-impounded River Existing tributary/boundary inflows No point sources	Daily site potential temperatures for 30-year period (10,950 values) Mean daily site potential temperatures (365 values)	Temperatures exceed numeric criteria (e.g., 20 deg C in lower Columbia) in absence of human activity on mainstems
2. Actual Temperature	Daily Time Step Impounded River Existing tributary/boundary inflows All point sources	Daily actual temperatures for 30-year period (10,950 values) Mean daily actual temperatures (365 values)	Actual temperatures are higher than site potential temperatures in late summer/fall (e.g., 3.5 deg C warmer at John Day dam)
3. Point Source Cumulative Impacts	Daily Time Step Impounded River Existing tributary/boundary inflows Point Sources - 2 scenarios Scenario 1: No point sources Scenario 2: All point sources	Maximum daily temperature impacts for 30-year period (scenario 2 - scenario 1)	Maximum, cumulative point source impact less than 0.14 deg C when site potential exceeds 20 deg C. At other times, impact exceeds 0.14 but is far below allowable impact of 1.1 deg C.
4. Individual Dam Impacts	Daily Time Step Impounded River Existing tributary/boundary inflows No point sources Dams - 16 scenarios - Scenario 1: all dams included Scenarios 2-16: one dam removed & effects evaluated	Daily impacts for 30-year record (scenario1 - scenario 2-16) Mean daily impacts for 30-year record	Maximum temperature increases due to dams range from 0.1 deg C (Rock Island) to 6.2 deg C (Grand Coulee)

5. TMDL Target Temperatures	Daily Time Step Un-impounded River Existing tributary/boundary inflows All point sources Dams - 2 seasons: Aug-Oct: Actual effects from 5 dams (Wells, Rocky Reach, Rock Island, Priest Rapids, and The Dalles). No effect from other 10 dams Nov-Feb: Actual effects from 5 dams (Wells, Rocky Reach, Rock Island, Priest Rapids, and The Dalles), plus 0.12 deg C effect from remaining dams	Mean daily target temperatures for 30-year record	Fully allocates allowable temperature increment, based on compliance with standards at RM42
6. Diurnal Fluctuation	Hourly time step Impounded and Un-impounded Existing tributary/boundary inflows All point sources All dams (for impounded scenario)	Hourly average temperatures for 30-year record, impounded and un-impounded	Greater diurnal fluctuations in un-impounded river than impounded river

3.2 Site Potential Temperature

Simulation of the unimpounded rivers with no point sources provides the cross-sectional average temperatures that would occur in the Columbia and Snake rivers within the TMDL study area in the absence of human activity within the main stem of the rivers. These temperatures are referred to in the TMDL as site potential temperatures. As the name implies, they are the temperatures that could occur in the Columbia and Snake rivers within the TMDL study area if the influence of human activity in the main stems on water temperature is eliminated. But the human influence outside the TMDL study area still remains. The inputs to the model; main stem temperature and flow, tributary temperature and flow and weather are not natural conditions. Flows in the main stem and the tributaries have been permanently altered by the construction of dams irrigation withdrawals and other consumptive uses. So the term site potential is used to indicate that the simulations do not recreate the water temperatures that preceded European influence in North America. The modeling effort, by removing the impacts of all human activity from within the main-stems themselves, is a reasonable approach to use to assess natural temperature conditions

There is one exception to the use of actual conditions at the boundaries of the TMDL. Dworshak Dam on the North Fork of the Clearwater River can be operated so as to discharge deep, colder water from its reservoir as a means of improving flow and temperature conditions downstream in the Snake River to aid in the recovery of endangered salmon. Though Dworshak Dam has always released colder water into the Clearwater River, it has been operated to aid salmon recovery, to varying degrees since 1991. The 2000 Biological Opinion on operation of the Federal Columbia River Power System contains an action in the Reasonable and Prudent Alternative (Action 19) that calls for the management of Dworshak discharge to attempt to maintain water temperatures at the Lower Granite Reservoir forebay dissolved gas monitoring station at or below 20 EC. Since these Dworshak releases are not standard operating procedure at Dworshak but are instead part of implementation efforts for restoring temperatures in the river they are not included in the simulations of site potential temperature. Clearwater Rivers flows and temperatures in the model have been adjusted to eliminate those additional releases from the Dworshak Dam from 1991 through 1999 that were intended for salmon and water quality recovery in the lower Snake River.

The Northwest Power Planing Council's Independent Science Group in their report "Return to the River" note the need to study the effect of unnaturally cold reaches of the Snake and Clearwater Rivers (below Hells Canyon and Dworshak Dams respectively) on fall Chinook (ISG, 2000). That the Clearwater River is cooler in the summer than it was prior to 1972 when Dworshak Reservoir began storing water is shown by USGS water temperature records at the Peck gage which date back to 1967 . Also, as is typical of regulated rivers, summer flows are greater now than for the previously un-impounded river. This has made the Clearwater River a source of anthropogenic cooling, not warming, to the lower Snake River. This effect has been manipulated since 1991 to increase coldwater releases specifically to further cool the lower

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Water temperature data are available for the USGS gage on the Clearwater River @ Peck, a few miles below the confluence of the North Fork Clearwater, for 1967 to present, pre-dating Dworshak Dam on the North Fork by 5 years. More recent USGS data - from the NF Clearwater above Dworshak Reservoir, the main Clearwater @ Orofino (just above the NF confluence), and an additional downstream site on the Clearwater @ Spalding - show the cooling that operation of Dworshak Dam has had on the lower Clearwater River.

Snake River so as to aid salmon passage. A similar but not so dramatic summer cooling effect is also evident in the Snake River due to Brownlee Reservoir. Although Snake River flows have also been augmented since 1991 to aid salmon passage (aka the 'salmon flush') these flows have not specifically been targeted toward temperature management. Furthermore, while the Snake River downstream of Hells Canyon appears to be cooler in summer, it also appears to be warmer in the fall than would be the un-impounded river.

Figure 3-1 illustrates the site potential temperature and the impounded temperature during 1977 at John Day Dam as simulated by the RBM10 model. The figure illustrates the typical differences between the site potential or free flowing river and the existing impounded river. The free flowing river tends to cool faster in the fall and winter. Temperature in the free flowing river also tends to vary more in response to changes in air temperature. Water temperature is not constant throughout the year. Neither is it constant from year to year or along the length of the river. There are warm years and cool years and the water temperature changes as the water moves downstream. The estimates of site potential and ultimately the TMDL target temperatures have to account for that variation.

The longitudinal variability is captured by dividing the river into a series of reaches and estimating the site potential at a target site in each reach. In this TMDL, 21 reaches are designated. See Section 5.0 for a complete discussion of the establishment of target sites for the TMDL. The year to year variability in site potential temperature was captured by simulating 30 years of site potential temperatures and computing the mean site potential temperature for every day of the year. Figure 3-2 illustrates the variability of site potential temperatures and the mean site potential at John Day Dam as simulated by RBM10. The 30 year mean site potential temperatures for every day of the year form the basis for this TMDL and the target temperatures that the TMDL is intended to achieve are expressed as 30 year means for every day of the year (see section 5). This is a reasonable approach for developing a TMDL when the target temperatures can fluctuate. When the TMDL is successfully implemented, water temperature during specific years will be warmer or cooler than the target temperature (a 30 year mean) because of the natural variability that occurs, but the long term mean temperatures should closely approximate the target temperatures. In Figure 3-2, the black curve labeled “IMP” represents the 30 year mean temperature under the existing impounded river conditions. The difference between the white site potential curve and the back impounded curve shows the improvement in long term mean water temperature called for by the TMDL at John Day Dam.

3.3 Implications of Using Daily Cross Sectional Average Temperature

The site potential temperatures which form the basis for the target temperatures in this TMDL are based on simulations of daily cross sectional average temperature. The water quality standards of the 3 states and tribe for temperature include numeric criteria written in terms of maximum temperature or seven day average of daily maximum temperatures. However, the standards do allow temperature to exceed natural (site potential) temperature by small incremental amounts when the natural temperatures exceed numeric criteria (see Table 2-3). None of the applicable standards specify the units in which the natural temperatures are to be expressed. It would be reasonable to use the same units that are utilized for the numeric criteria. However, as discussed below, due to the relationship which exists between daily average and daily maximum temperatures in the Columbia and lower Snake Rivers, it is also reasonable to utilize simulations of the daily average temperature as a surrogate for daily maximum temperatures in this TMDL.

Considering the temporal and spatial variation of temperature in the free flowing and impounded rivers, the daily cross sectional average temperature is appropriate to use in the TMDL for the following reasons.

$ The free flowing river was well mixed and achieved the cross section average temperature in most of the water body.
$ Daily cross sectional average temperature exhibits the same patterns of seasonal fluctuation as daily maximum temperature.
$ The daily maximum temperature can be less protective than the daily average temperature due to the manner in which dams effect water temperature.
$ Analysis indicates that attainment of the daily average site potential temperature will also lead to attainment of the daily maximum site potential temperature.

The un-impounded or free flowing Columbia and Snake rivers were generally well mixed. Some temperature variation likely occurred in very shallow areas, around rocky protuberances and in static back waters because such areas warm faster toward equilibrium temperatures no matter what the thalweg temperature. Also, localized cool areas likely existed where groundwater or hyporheic up-welling occurred. But mixing would have occurred within the thalweg because of the rapid flow, intermittent rapids and water falls and diverse variety of instream channel features. Thus, the simulated cross sectional average temperature of the free flowing river is a good representation of the site potential temperature of the water body.

The TMDL target temperatures are daily cross sectional averages but, as in the free flowing river, they are to be achieved throughout the main river flow or thalweg. The TMDL would neither comply with water quality standards nor be protective of coldwater fish if it allowed two or three degree or greater temperature increases in the surface waters above natural. In the locations of importance to fish (e.g., along the thalweg, critical salmon habitat, fish ladders and fish holding facilities) target temperatures apply at all depths. At the same time, some isolated areas within the river should not be expected to achieve the targets, such as at the face of the dams, in shallow stagnant backwaters, or along rocky protuberances.

Simulations of hourly average temperature using the RBM 10 model were run to determine daily maximum temperatures in the rivers under free flowing and impounded conditions. The highest hourly average temperature each day approximates the daily maximum temperature. Figure 3-3 compares simulations of hourly average and daily average temperature during 1997 at Lower Granite Dam. The figure demonstrates that the two measures of temperature, daily average and daily maximum exhibit the same seasonal variations.

Water temperature can vary throughout the day with changing air temperature and solar radiation. Simulations of hourly average temperature using the RBM 10 model demonstrate that the diel variation in the free flowing or site potential river is generally greater than in the impounded river. Figures 3-4 , 3-5 and 3-6 demonstrate this point using temperature simulations at Grand Coulee, Lower Granite and Bonneville dams during 1992. Notice at Grand Coulee Dam, diurnal fluctuation is almost nonexistent in the impounded river while the free flowing river temperature varies as much as 1.5 E C during the day. At Lower Granite Dam the impounded river fluctuated about a half a degree but the free flowing river fluctuated 1.5 E C or more. At Bonneville the daily fluctuation in the free flowing river is about 3 times greater than in the impounded river. We simulated the hourly average temperature at five dams for two years to compare the daily temperature fluctuation in the impounded and free flowing rivers. We compared the daily fluctuation in temperature at the five dams for the two years. Table 3-2 summarizes the results.

Table 3-2 shows the mean fluctuation in temperature during the day along with the smallest and largest daily fluctuations that occurred. Note that at all five dams during both years the greatest fluctuation in temperature occurred in the free flowing river. Lower Granite Dam during 1997 is the only data set that was at all ambiguous, with the daily fluctuation being very similar in the impounded and free flowing rivers. However, 1997 was an unusually high flow year. The flow rate through the river system was so fast that the initial temperature conditions at the model boundary, rather than heat exchange during the day, drove the temperature during the day. But even that year, the daily temperature fluctuation of the impounded river was generally within the daily fluctuation of the free flowing river.

Since the impounded river temperature fluctuates less during the day, establishing the TMDL at the daily maximum temperature could be less protective than called for by the water quality standards. Consider Figure 3-6. If the TMDL is established to achieve daily maximum site potential temperatures in the impounded river, the water temperature at Bonneville Dam

Table 3-2:Comparison of Daily Temperature Fluctuation of the Columbia and Snake Rivers Under Impounded and Free Flowing Conditions

	Grand Coulee 1997		Priest Rapids 1997		Bonneville 1997	
	Impounded	Free Flowing	Impounded	Free Flowing	Impounded	Free Flowing
n	0.203	0.563	0.428	0.616	0.509	0.749
dard Deviation	0.164	0.347	0.250	0.321	0.330	0.391
mum	0.000	0.113	0.016	0.069	0.063	0.110
imum	0.898	2.379	1.284	2.372	1.591	1.981
	Grand Coulee 1992		***Priest Rapids 1992***		***Bonneville 1992***	
	Impounded	*Free Flowing*	*Impounded*	*Free Flowing*	*Impounded*	*Free Flowing*
Mean	*0.160*	*0.886*	*0.386*	*0.697*	*0.320*	*0.950*
ndard Deviation	*0.143*	*0.483*	*0.246*	*0.390*	*0.188*	*0.468*
Minimum	*0.000*	*0.116*	*0.039*	*0.011*	*0.045*	*0.148*
Maximum	*0.820*	*3.658*	*1.377*	*2.448*	*1.186*	*2.584*

	Lower Granite 1997		Ice Harbor 1997	
	Impounded	Free Flowing	Impounded	Free Flowing
Mean	0.580	0.787	0.461	0.841
Standard Deviation	0.428	0.415	0.338	0.414
Minimum	0.049	0.156	0.039	0.131
Maximum	3.132	3.437	2.656	3.144
	Lower Granite 1992		***Ice Harbor 1992***	
	Impounded	Free Flowing	Impounded	Free Flowing
Mean	0.558	1.129	0.278	1.234
Standard Deviation	0.469	0.602	0.263	0.814
Minimum	0.035	0.165	0.018	0.157
Maximum	2.458	3.425	1.643	4.156

during the night, temperature would be as much as 1.5 EC warmer than the site potential temperature. Under this scenario the river at Bonneville Dam would be under-protected because it would carry a heat load during the 24 hour day higher than the site potential river. If the TMDL is established to achieve the daily average temperature, the river won't achieve the coolest temperatures during the night but neither will it reach the hottest day time temperature and its overall heat load during the 24 hour period will be similar to that of the free flowing river. So establishing the TMDL to achieve the daily average temperature will allow less heat load during the day and be more protective. Therefore, the daily average temperature is a more appropriate measure to ensure that human activity does not cause the temperature to exceed site potential temperature.

Since the impounded river temperature fluctuates less during the day than the free flowing river, attainment of the daily average site potential temperature will lead to attainment of the daily maximum site potential temperature as well. Consider an example in which the site potential daily average temperature is 20 EC with a temperature fluctuation during the day of 1.5 EC and the impounded river has a daily fluctuation 0.5 E. If the impounded river achieves the daily average of 20 EC it will stay within the daily maximum of 20.75 EC. However the reverse is not true. If the impounded river is brought into compliance with the daily maximum of 20.75 EC, its daily average will be around 20.5 EC, above the daily average site potential temperature. Again, the daily average site potential temperature is a more appropriate basis for the target temperatures for this TMDL.

The last concern about daily averaging is the possibility that there are days in which the daily maximum site potential temperature exceeds the criteria but the daily average does not. If this were to happen we would be setting target temperatures on the basis of site potential being less than criteria instead of greater than criteria. Examination of RBM 10 simulations of hourly average temperatures indicate that if this happens at all it is normally 1 day at the beginning of the time period when criteria are exceeded and 1 day at the end. The number of days could increase if the site potential temperature repeatedly exceeded then dipped below criteria throughout the warm period but since we are using 30 year average temperatures this never happens.

Summary

$ WQS have criteria based on daily maximum temperatures.
$ The standards themselves allow temperature to exceed natural (site potential) temperature by small incremental amounts and do not specify the units of measure for natural temperature.
$ The target temperature applies throughout the width and depth of the river and in critical salmon habitat and holding areas.
$ Daily average and daily maximum temperatures exhibit the same seasonal patterns.

$ Using daily maximum site potential temperature to establish target temperatures could result in under-protecting temperature during much of the day.
$ Attainment of the daily average site potential temperature will lead to attainment of the daily maximum site potential temperature as well
$ Using daily average site potential to determine if criteria are exceeded might underestimate days of exceedance by 1 day at the beginning of the warm period and one day at the end, but using the thirty year average period makes this insignificant.
$ Throughout this report, temperature simulations and references to water temperature refer to daily cross sectional average temperatures unless otherwise noted.

4.0 Current Temperature Conditions

4.1 General

Temperature conditions in the Columbia and Snake river main stems are discussed in detail in Appendix A, “Problem Assessment for the Columbia/Snake River Temperature TMDL” (Problem Assessment). The Problem Assessment uses both existing temperature data and mathematical modeling of temperature to describe the existing temperature regime of the impounded river and the site potential temperature regime of the un-impounded or free flowing river.

Both the temperature observations and the temperature simulations provide estimates of water temperature. Since there are information gaps and uncertainties associated with both the observations and the simulations, both are used to gain an understanding of the free flowing and impounded temperature regimes and the relative importance of dams, point sources and tributaries in altering the natural regime of the rivers.

There is a considerable record of temperature data from the Columbia and Snake Rivers. McKenzie and Laenen (1998) assembled temperature data from 84 stations along the two rivers within the study area of this TMDL. However, the extensive data base from along the rivers must be used with caution. Little, if any of the data collected before year 2000 were collected with the express objective of evaluating temperature in the river and few of the sampling sites had quality assurance objectives or followed quality control plans. Temperature measured at the same time at one dam can vary quite a bit depending on whether it was measured in the forebay, the tail race or the scroll case. In using these data it is important to compare like stations along the river (e.g. scroll case to scroll case, forebay to forebay) and to use long records or repetitive examples when drawing general conclusions about temperature trends.

The RBM10 temperature model was developed to augment the understanding of temperature in the river derived from analysis of the data record. There is a good deal of information available for development of the temperature model. For example there are 30 years of continuous weather, flow and water temperature data. However, there are also modeling challenges that cause uncertainty in the modeling results. For example there is little information on temperature in the free flowing river to compare with simulated temperatures. Therefore, the problem assessment relies heavily on both data analysis and modeling analysis.

The analysis in the Problem Assessment provides the following information about the natural and existing temperature regimes of the river:

- The temperatures of the Columbia and Snake rivers frequently exceed state and tribal numeric water quality criteria for temperature during the summer months throughout the area covered by this TMDL.

- The water temperatures of the rivers before construction of the dams could get quite warm, at times exceeding the 20 ^{o}C temperature criteria of Oregon and Washington on the lower Columbia River.

- However, these warm temperatures were much less frequent without the dams in place. Temperature observations show that the frequency of exceedances at Bonneville Dam of 20 ^{o}C increased from about 3% when Bonneville was the only dam on the lower river to 13% with all the dams in place.

- The dams appear to be a major cause of warming of the temperature regimes of the rivers. Model simulations using the existing temperatures of tributaries and holding tributary temperatures to 16 ^{o}C revealed little difference in the frequency of excursion of 20 ^{o}C.

- Climate change may play a role in warming the temperature regime of the Columbia River. The Fraser River, with no dams, shows an increasing trend in average summer time temperature of 0.012 ^{o}C/year since 1941, 0.022 ^{o}C/year since 1953.

- The average water temperatures of the free flowing river exhibited greater diurnal fluctuations than the impounded river.

- The free flowing river average water temperature fluctuated in response to meteorology more than the impounded river. Cooling weather patterns tended to cool the free flowing river but have little effect on the average temperature of the impounded river.

- The free flowing river water temperatures cooled more quickly in the late summer and fall.

- Alluvial flood plains scattered along the rivers moderated water temperatures, at least locally, and provided cool water refugia along the length of the rivers.

- The existing river can experience temperature gradients in the reservoirs in which the shallow waters are warmer.

$ Fish ladders, which provide the only route of passage for adult salmon around the dams, can become warmer than the surrounding river water.

4.2 Relative Impact of Dams, Tributaries and Point Sources

Point and non-point sources affect water temperature by directly adding warm water to the main stems. There are 106 point sources with individual NPDES permits that directly discharge to the mainstems evaluated in this TMDL. There are currently 96 point sources with General NPDES permits. Non-point sources tend to discharge to small streams and rivers in the watershed which eventually empty into the mainstems. There are 193 tributaries to the two main stems, including 7 significant irrigation return flows. Dams affect water temperature not by adding warm water to the system, but by altering the river flow, geometry and velocity upstream of the dam. This section discusses and compares the impacts from each of these kinds of heat sources.

Advected Sources of Heat - Tributaries and Point Sources

The impact of advected sources of heat such as tributaries and point sources on the cross-sectional average temperature of the main stem Columbia and Snake Rivers is determined by the ratio of advected energy from the source to the advected energy of the main stems. Mathematically, the new main stem temperature resulting from complete mixing with a tributary or point source is expressed as:

Equation 4.1:

$$T_{new} = [(Q_{main\ stem} * T_{main\ stem}) + (Q_{source} * T_{source})]/(Q_{main\ stem} + Q_{source})$$

T = temperature
Q = flow

The Columbia and Snake Rivers are both quite large. The 7Q10 low flow of the Columbia ranges from 45,400 CFS at Grand Coulee Dam to 93,652 below Longview, WA. The 7Q10 low flow of the lower Snake is 14,500 CFS. Both rivers can accept a large advected thermal load without measurably increasing their temperature. For example, the largest/hottest point source in the Columbia River has a maximum discharge of 117 CFS and a maximum temperature of 39 EC. When mixed with the Columbia River at its 7Q10 low flow and 20 EC, it raises the average temperature of the Columbia by 0.02 EC. The largest discharger on the Snake River has a maximum flow of 62 CFS and a maximum temperature of 34 EC. When mixed with the Snake River at a 7Q10 low flow of 14,500 cfs and 20 EC, it raises the temperature of the

Snake by 0.06 EC. Therefore, individual point source discharges to the Columbia and Snake rivers do not measurably increase the cross-sectional average temperature of the rivers.

RBM 10 was used to further evaluate the cumulative effects of point sources on water temperature in the Columbia and Snake Rivers. Water temperature in the river was simulated with all the point sources in place and with all the point sources removed. Permit limits, or in the absence of permit limits, reasonable worst case temperature and flow rates were used for the point sources with individual NPDES permits. In order to account for point sources discharging under general NPDES permits and allow for future growth, 20 MW of heat energy was added at each TMDL target site. The target sites are explained in Section 5.2. Actual flow and weather data from 1970 through 1999 were used for simulating the river water temperature. Figures 4-1 and 4-2 plot the increase in temperature due to the presence of the point sources in the river throughout the thirty year period at river mile 42 in the Columbia River. Figure 4-1 shows all the data for the thirty year period. Figure 4-2 shows the data for times during which the river water temperature exceeded the 20 EC criterion. River mile 42 was selected as an example plot because it is the location where the increase due to point sources is greatest. Recall from Table 2-3 that the water quality standard for this stretch of river is natural temperature + 1.1 EC when natural is less than 20 EC, and natural + 0.14 EC when natural is above 20 EC. Note from Figure 4-1 that the increase due to point sources never approaches the 1.1 EC allowed by water quality standards when site potential is below the criterion. When site potential is above the criterion, temperature approaches but never exceeds the 0.14 EC increase allowed by the water quality standards (Figure 4-2). At most sites in the river, the impact of the point sources on water temperature was much less than shown here. At Wanapum, for example, the impact never exceeded 0.031 EC throughout the 30 years. The effect of existing point sources on water temperature is very small and, in and of themselves, the point sources do not lead to exceedances of water quality standards when averaged in with the total flow of the river.

But the discharges do cause near-field temperature plumes that can exceed temperature standards. Even when the discharge causes no measurable increase in cross-sectional average temperature, the temperature plume could be significant with respect to aquatic life habitat if left uncontrolled. The state and tribal WQS contain provisions to regulate the size and impact of these plumes.

Like the point sources, most of the tributaries have negligible effects on the cross sectional average temperature of the main stems. To illustrate this, Table 4-1 lists a number of the major tributaries to the Columbia and Snake rivers, their average flows, the average flows of the Columbia and Snake and the temperature difference between the tributary and the main stem that would be required to increase main stem temperature by 0.5 EC and 0.14 EC at those flow ratios.

Note that only the Spokane, Snake and Willamette Rivers are large enough to potentially alter the temperature of the Columbia River by a measurable amount (0.14 EC). Only the

Salmon, Grande Ronde and Clearwater Rivers are large enough to potentially alter the temperature of the Snake River by a measurable amount (0.14 EC).

Table 4-1: Effects of Specified Tributaries on Columbia and Snake River Temperature

Tributary	Average Flow (CFS)	Columbia Average Flow (CFS)	♠T (EC) to raise Columbia Temperature	
			0.5 EC	**0.14EC**
Spokane River	7,812	~ 100,000	7.0	1.9
Okanagan River	3,145	~106,255	17.0	4.9
Yakima River	3,569	~118,400	17.0	4.8
Snake River	55,090	~118,400	1.6	0.44
Deschutes	5,839	~185,161	16.0	4.6
Willamette	34,205	~191,000	3.2	0.92
		Snake Average Flow (CFS)	**♠T (EC) to raise Snake Temperature**	
			0.5 EC	**0.14EC**
Salmon	11240	~23560	1.5	0.43
Grande Ronde	3101	~34800	6.0	1.7
Clearwater	15430	~37901	1.5	0.48

One way to evaluate and compare temperature conditions is to enumerate the number of days in a year, or the frequency, that a specified temperature is exceeded. In order to determine the importance of tributaries to the main stems' temperature regimes, the RBM10 model was used to compare the frequency with which temperature exceeds 20 EC in the main stems under existing conditions with the frequency of exceedances of 20 EC in the main stems if the tributaries never exceed 16 EC. That is, in the first simulation, actual tributary temperatures were used. In the second simulation, the tributary temperatures were not allowed to exceed 16 EC. Figures 4-3 and 4-4 illustrate the results. The effect of restraining tributaries to 16 EC is very small in the Columbia upstream of its confluence with the Snake. The combined average annual flows of advected sources in this segment are less than 10 percent of the average annual flow of the Columbia River at Grand Coulee Dam. Downstream of the Snake River (River Mile 326) there is a small effect. The Snake River was not constrained to 16 EC, but the reductions in Snake tributary temperatures, particularly, the Salmon and Clearwater rivers resulted in slightly less frequency of exceedances in the lower Columbia. On the Snake River, holding the Salmon and Clearwater rivers to 16 EC clearly affected the frequency. But the other tributaries have little effect so that at the mouth of the Snake River, the frequency of exceedances in the Snake was similar to the existing condition.

Dams as Sources of Heat

Model simulation results in Figure 3-1 illustrate the effect that dams have on temperature in the main stem. Note that the impounded and free flowing rivers warm up at approximately the same rate in the spring. However, the free flowing river cools off in the late summer and fall faster than the impounded river. At John Day Dam, on average, the impounded river temperature returned below 20 EC three weeks after the site potential river. In the early fall, on average, the free flowing river was as much as 3.5 degrees cooler. In short, dams effect water temperature in the main stem by adding to the length of time that temperature exceeds the numeric criterion, and by causing the river to be warmer during the late summer and fall.

To determine the effect of each individual dam on water temperature, the RBM 10 model was used to estimate what the water temperature would be if the individual dams were removed one at a time. The results for all the dams are depicted graphically in Appendix F. Table 4-2 shows the maximum temperature increase caused by each dam. Note that the dams as a group very widely in their effects on temperature. In fact, there appear to be three fairly distinct groups of dams based on their temperature effects. First, there is a group of six dams that clearly increase temperature by more than a degree centigrade and up to as much as 6 EC. These six dams are Grand Coulee, John Day, Lower Granite, Little Goose, Lower Monumental and Ice Harbor. Second, there is a group of two dams that have highly variable impacts on temperature up to a degree centigrade. These are Chief Joseph and Wanapum. Finally, there is a group of seven dams with highly variable impacts ranging from no impact to a maximum impact of 0.5 EC. These dams are Wells, Rocky Reach, Rock Island, Priest Rapids, McNary, The Dalles and Bonneville. Rocky Reach and Rock Island do not have a measurable effect (>0.14EC) on temperature. At Wells, Rocky Reach and Rock Island the temperature effect is so small and so variable that they actually have a cooling effect on the river on the average. The Dalles has a warming effect but it is less than measurable all except one day of the year.

Table 4-2: Each dam's maximum effect on temperature at that dam site

Facility	Maximum Impact	Facility	Maximum Impact
Grand Coulee	6.23 EC	John Day	1.39 EC

Chief Joseph	0.69 EC	The Dalles	0.147 EC
Wells	0.22 EC	Bonneville	0.27 EC
Rocky Reach	0.13 EC	Lower Granite	2.08 EC
Rock Island	0.07 EC	Little Goose	2.18 EC
Wanapum	0.86 EC	Lower Monumental	1.31 EC
Priest Rapids	0.28 EC	Ice Harbor	1.20 EC
McNary	0.36 EC		

4.3 Summary

The effects of the tributaries and point sources on cross sectional average water temperatures in the main stems are for the most part quite small. The exceptions are the major tributaries: Spokane River, Snake River and Willamette River on the Columbia and Salmon River and Clearwater River on the Snake. The point sources can cause temperature plumes in the near-field but they do not result in measurable increases to the cross-sectional average temperature of the main stems. Three of the dams, like the point sources, cause no measurable increase in cross sectional average temperature. Some of the dams, however do alter the cross-sectional average temperature of the main stems and they extend the period of time during which the water temperature exceeds numeric temperature criteria.

5.0 Derivation of TMDL Elements

5.1 General

The target temperatures for this TMDL are the mean site potential temperatures plus the incremental increases allowed by the WQS (see Section 2). These allowable increases vary with jurisdiction, location in the river and the site potential temperature. Where jurisdictions overlap, the allowable incremental increases in this TMDL are based on the more stringent WQS. Table 2-3 lists the allowable increases over the site potential by river reach after accounting for differences between jurisdictions.

The water quality standards divide the Columbia and Snake rivers into different reaches, each with different target temperatures to meet as shown in Table 2-3. The target temperatures result from adding the allowable increases to the site potential temperature. However, whenever the allowable increase in a river reach would result in exceedance of the water quality standards downstream of that reach, the target temperature has to be adjusted down so that it does not result in exceedance of down stream water quality standards. This actually is the case all along the rivers. RBM10 simulations indicate that the reaches cannot be allocated the full incremental increase allowed by their segment-specific standards, because these increases would cause exceedances of downstream standards. The Oregon water quality standards for the lowest reach on the river, along the Oregon/Washington border (see Table 2-3), limit the allowable increase in temperature in the rest of the Columbia and Snake Rivers.

5.2 Target Sites

The TMDL must allocate heat to 933 river miles to achieve the WQS at the furthest downstream reach of the river. The extent of this pollution problem and the attempt to address it at the basin scale necessitates the selection of a number of points-of-compliance or "target sites" that span the 933 miles. Target sites are locations in the river where the site potential temperatures are calculated and where impacts from allocations to up-gradient sources are evaluated.

In selecting target site locations, one option would be to use the downstream boundary of each reach as defined in the WQS. However, those reaches (identified in Table 2-3) are quite large and vary considerably in terms of the heat sources they contain. The reaches defined in the WQS vary from containing no dams to containing 5 dams. They also vary in terms of the number of point sources they contain: ranging from no point sources to 65 point sources.

Another option, and the one selected for development of this TMDL, is to establish target sites at each dam location. As discussed in Section 4.2, the fifteen dams on the rivers have the greatest effect on temperature. The dam locations have also been the primary long-term monitoring locations in the basin. Therefore, each dam defines a reach for the TMDL with the dam located at the downstream end of the reach. Downstream of Bonneville Dam, five additional target sites are established on the basis of the distribution of point sources. River mile 112 is in the vicinity of the Portland Airport and at the downstream extremity of salmon spawning. River mile 95 is downstream of Portland and Vancouver. River mile 63 is downstream of Longview and six large dischargers. River mile 42 is downstream of all the large dischargers and was chosen as a target site because the cumulative impacts of all the point sources is greatest at that point. River mile 4 was chosen as the last target site because further downstream the river is more like an estuary than a river. In the Snake River, one additional target site was created at river mile 138, just downstream of Lewiston, ID. The target site or monitoring point for each reach is at the downstream end. For the dam reaches, the primary monitoring point is in the forebay of the dam. Table 5-1 lists the target sites for each reach of the TMDL.

Table 5-1: TMDL Target Sites

TMDL Reach	Target Site	River Mile
Columbia River		
Canadian Border to Grand Coulee Dam	Grand Coulee Dam	Columbia - 596.6
Grand Coulee Dam to Chief Joseph Dam	Chief Joseph Dam	Columbia - 545.1
Chief Joseph Dam to Wells Dam	Wells Dam	Columbia - 515.8
Wells Dam To Rocky Reach Dam	Rocky Reach Dam	Columbia - 473.7
Rocky Reach Dam to Rock Island Dam	Rock Island Dam	Columbia - 453.4
Rock Island Dam to Wanapum Dam	Wanapum Dam	Columbia - 415.4
Wanapum Dam to Priest Rapids Dam	Priest Rapids Dam	Columbia - 397.1
Priest Rapids Dam to McNary Dam	McNary Dam	Columbia - 292.0
McNary Dam to John Day Dam	John Day Dam	Columbia - 215.6
John Day Dam to The Dalles Dam	The Dalles Dam	Columbia - 191.5
The Dalles Dam to Bonneville Dam	Bonneville Dam	Columbia - 146.1
Bonneville Dam to River Mile 112	River Mile 112	Columbia - 112
River Mile 112 to River Mile 95	River Mile 95	Columbia - 95
River Mile 95 to River Mile 63	River Mile 63	Columbia - 63
River Mile 63 to River Mile 42	River Mile 42	Columbia - 42
River Mile 42 to River Mile 4	River Mile 4	Columbia - 4
Snake River		
Salmon River to RM 138	River Mile 138	Snake - 138
River Mile 138 to Lower Granite Dam	Lower Granite Dam	Snake - 107.5
Lower Granite Dam to Little Goose Dam	Little Goose Dam	Snake - 70.3
Little Goose Dam to Lower Monumental Dam	Lower Monumental Dam	Snake - 41.6
Lower Monumental Dam to Ice Harbor Dam	Ice Harbor Dam	Snake - 9.7

Critical Reach and Target Site

Analysis of the water quality standards and location of dams and significant point sources indicates that the critical location for cumulative temperature impacts is RM 42. As noted above, upstream target temperatures have been established to ensure that downstream criteria are attained. In all the upstream reaches, the target temperatures have been established at levels slightly less than water quality criteria for those reaches in order that criteria may be achieved at River Mile 42.

5.3 Seasonal Variation

This TMDL addresses seasonal variability in two respects. First, the TMDL addresses the seasonal variations in the numeric water quality criteria for temperature. Second, the model developed to estimate river temperatures addresses the variability in temperature in the mainstem rivers.

Seasonal Water Quality Standards

Figure 5-1 is intended to illustrate the seasonal variation in the water quality standards, in water temperature, and in the effect that human activity has on water temperature at the critical target site. The figure shows the water quality criteria and the temperature regimes of the site potential and existing rivers at Columbia River Mile 42. The green lines depict the water quality criteria: 20 EC from June 1 through September 30 (day 152 through day 273) and 12.8 EC from October 1 through May 31 (day 274 through day 151). If the site potential temperatures exceed 20 EC from June 1 through September 30 and/or 12.8 EC from October 1 through May 31, then human activity can increase temperature over the site potential by only 0.14 EC. Any time that the site potential temperature is less than the applicable criterion (either 20 EC or 12.8 EC) then human activity can increase temperature over the site potential by 1.1 EC or up to the criterion which ever is less. See Section 2 and Table 2-3 for a description of the applicable water quality standards.

The blue and red curves on the graph represent site potential temperature and existing temperature respectively. There are four important observations from Figure 5-1:

1. water temperature does vary seasonally as would be expected;
2. both the site potential and the existing temperatures exceed the 20 EC criterion in the summer and the 12.8EC criterion in the fall.
3. The existing temperatures exceed the site potential temperatures in the summer, fall and early winter; and
4. The existing temperatures do not exceed site potential temperatures in the late winter, spring and early summer.

These observations on the seasonal variation of temperature in the river and the effects of human activity on temperature govern the development of the TMDL. Based on model simulations of the cross-sectional average temperature, existing temperatures do not exceed site potential temperatures from February 6 through July 31. As noted earlier, surface heating occurs in the summer months in the impounded areas of the mainstems.. Based on a review of temperature data from the fore bays of the dams between 1997 and 2002, surface water temperatures begin to exceed both the site potential temperature and the 20 EC criterion at the beginning of July. Therefore, beginning on July 1, water quality standards are exceeded and the

TMDL must include allocations to ensure that temperature does not exceed site potential temperature by more than 0.14 EC.

Beginning on October 1 until almost October 31, existing temperatures exceed site potential temperature and the 12.8 EC criterion. Therefore water quality standards are exceeded and the TMDL must include allocations to ensure that temperature does not exceed site potential temperature by more than 0.14 EC.

Beginning on November 1 until February 5, existing temperatures exceed site potential temperatures but not the criteria. Water quality standards are exceeded but in this case the TMDL must include allocations to ensure that temperature does not exceed site potential temperature by more than 1.1 EC.

In summary, the water quality standards for temperature, temperature itself and the effects of human activities on temperature all vary seasonally during the year. In the winter and spring, water quality standards are not exceeded, and therefore the waters of the Columbia and Snake rivers are not impaired for temperature from human activities within the main stems. In the late summer and fall, water quality standards are exceeded and the site potential temperatures exceed the water quality criteria, requiring TMDL allocations for temperature that ensure temperature doesn't exceed site potential temperature + 0.14 EC. In the late fall and early winter water quality standards are exceeded but the site potential is less than water quality criteria, requiring TMDL allocations that ensure temperatures don't exceed site potential + 1.1 EC. The seasonality of the TMDL is summarized as follows:

February 6 through July 1 - no allocations required;
July 1 through October 31 - allocations to achieve site potential Temperature + 0.14 EC;
November 1 through February 5 - allocations to achieve site potential Temperature + 1.1 EC.

Seasonal Variation of Mainstem River Temperatures

The water quality model used for this TMDL accounts for daily variation in boundary inflow conditions, tributary inflow conditions, and weather over a 30-year record (for details on underlying data, see Yearsley, et al, 2001). This model configuration explicitly captures the variability of the system and allows us to estimate the 30-year mean temperature at each location, for each calendar day. In establishing long-term target temperatures, there is a recognition that the natural variability of the system precludes a discrete-sample test for compliance with the water quality standards.

5.4 Critical Conditions

TMDLs must take into account critical conditions for stream flow, loading and water quality parameters (40 CFR § 130.7(c)(1)). In a TMDL, critical conditions are the conditions under which the pollutant sources can cause the water quality standards to be exceeded. Thus if WQS are met at the critical conditions they should also be met at the less than critical conditions.

It is difficult to establish critical conditions of stream flow, loading and water quality parameters (temperature in this case) for this TMDL because of the manner in which dams affect temperature and the manner in which the target temperature varies throughout the year. Dams do not discharge a heated effluent to the river. They affect temperature by altering stream geometry and current velocity. Therefore, dams don't necessarily have the greatest effect on temperature at the lowest flows as they would if they discharged a heated effluent at constant discharge rate to the river. Furthermore, since the target temperature varies throughout the year, the hottest time of the year is not necessarily the most likely time that water quality standards will be exceeded. To address these issues, critical conditions have been considered in this TMDL in two ways. First, the TMDL incorporates the natural variability in temperature by utilizing 30 years of hydrologic and climatic data and establishes target temperatures for each day of the year, thus accounting for temperature increases during all periods, not just the hot periods. Second, the TMDL is expressed in terms of temperature instead of load, more fully accounting for temperature increases under all possible flow (and therefore, load) conditions.

5.5 Loading Capacity

The loading capacity is defined as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 CFR 130.2(f)). Due to the language of the water quality standards and the characteristics of the temperature sources in the mainstems, the loading capacity for this TMDL has been expressed in terms of temperature rather than thermal load. The regulations governing TMDL development provide for the expression of TMDLs as "either mass per time, toxicity, or other appropriate measure" (40CFR130.2(h)). Temperature is an appropriate measure in this TMDL due to the large variation in daily flows experienced in the river due to human activities. Since river flow is regularly adjusted based on electricity, irrigation and fisheries requirements, a wide range of flows may be experienced on any single day. Thus, by modifying flow at any dam the river could experience a fluctuation in thermal load without realizing any change in temperature. Since it is ultimately the river temperature which is important to protecting the fisheries (the most sensitive beneficial use) and temperature is the measure of the applicable standard , it is more appropriate to express this TMDL in terms of temperature. In addition, temperature is an expression which is meaningful and can be more readily understood by the public, dam operators, and other stakeholders. As noted above, temperature can be easily converted to daily load at any given flow. However, little to no value would be added by this exercise.

Analysis of the water quality standards and location of dams and significant point sources indicates that the critical location for cumulative temperature impacts is RM 42. The loading capacity for this TMDL is therefore defined as the daily target temperature at this location, which is calculated as the site potential temperature plus the allowable temperature increase under the water quality standards (0.14 deg C and 1.1 deg C depending on the season).

To estimate the loading capacity, evaluate thermal impacts, and establish target temperatures for the mainstems, it is necessary to estimate the site potential temperatures. Recall from the discussion in Section 3.2 that the site potential temperature on a particular calendar day varies from year-to-year based on climatic and hydrologic conditions. To capture that variability, the site potential temperature at RM 42 was estimated using the available data and the RBM10 model. The model was run assuming the hydrodynamics of free-flowing mainstems and no thermal sources, and site potential temperature estimates were generated for each day of a 30 year record. From this record of daily temperature estimates (a total of 10,950 values), the mean temperature for each calendar day was calculated (365 values). Target temperatures at RM 42 were then calculated as the site potential temperature for each calendar day plus the allowable temperature increase.

The 30-year model was also used in the allocation process. At each stage of the allocation process, EPA ran the model and compared the predicted temperatures at RM 42 resulting from the allocation of heat loads to the target temperatures. Using trial-and-error simulations, heat source allocations were added in a prescribed method until the allowable incremental increases in temperature were reached at RM 42. The process by which the sources were added is outlined in following sections.

5.6 Allocations

This TMDL accounts for the contributing heat sources to the main stems: natural background conditions, tributaries (non-point sources), dams and point sources. For the purposes of this TMDL, natural background temperature is the site potential temperature. Tributaries are allocated their existing loads. Dams and point sources are allocated the allowable temperature increases over the site potential temperature to achieve the loading capacity (target temperature) at the Critical Target Site, RM 42. Target temperatures are also calculated for the other target site locations in the study area. In this section the terms "gross load allocation" and "gross wasteload allocation" refer to the temperature increase allowed in a river reach from dams and point sources respectively. Specific point source allocations will be given in Megawatts as will be discussed in Section 5.6.2. This section first describes how the gross wasteload allocations and load allocations were determined in sub-section 5.6.1. Sub-section 5.6.2 then provides details on determination of the specific wasteload allocations. Subsection 5.6.3 goes into detail on the load allocations.

5.6.1 Gross Allocations to Human Sources

The portion of the loading capacity available for allocation is equal to the allowable temperature increase above site potential conditions (0.14 deg C and 1.1 deg C depending on the season). The underlying philosophy used to establish this TMDL was to allocate available heat capacity to the smallest sources first and work up the list until the available capacity is fully allocated. That is, allocate existing heat load to as many sources as possible. This philosophy arises from the fact that there is insufficient capacity to provide the larger sources any meaningful relief since the capacity to be allocated is only 0.14 EC or 1.1 EC. Therefore, the TMDL first allocates sufficient loads to account for existing discharges from individual NPDES permittees and 20 MW at each target site to account for general NPDES permittees. Any future growth will have to be part of the 20 MW allocated to general permits. The TMDL then allocates remaining capacity to account for as many of the dams as possible beginning with the dams with the smallest effect on temperature. The process used to implement this underlying philosophy of the TMDL is described in detail below and illustrated in Figure 5-2.

The allocation to account for existing discharges from individual and general NPDES permittees was determined as follows. Thirty years of water temperature were simulated at each Target Site by RBM 10. The 30 year mean temperature and flow from those simulations and the current thermal loads from existing dischargers (including 20 MW for general permits and future growth) were used to calculate the mean increase in temperature at each target site that results from the point source allocation every day of the year. Figures 4-1 and 4-2 show that the point sources cause the river to approach water quality standards only when site potential temperature exceeds the numeric water quality criteria. Table 5-2, Column 2 shows the highest temperature increases at each target site caused by point sources when site potential temperatures exceed numeric criteria.

Allocation of the remaining capacity (after accounting for point sources) to account for as many of the dams as possible beginning with the dams with the smallest effect on temperature was done as follows. Using the 30-year record, RBM 10 was run iteratively, allocating sufficient temperature increase to the dams to account for their effect on temperature. We started with the dams with the smallest impacts (See Section 4.2 and Appendix F) and worked up the list until further allocations would result in exceedances in water quality standards. For the time period when site potential temperature tends to exceed the water quality criteria (July 1 through October 31), we could allocate sufficient temperature increases to three dams (Wells, Rocky Reach, and Rock Island) to account for their effects on temperature and at the same time achieve the loading capacity with zero excursions for the 30-year simulation. When the temperature increases due to the next two dams (in order of increasing impact), The Dalles and Priest Rapids, are added to the simulation, small exceedances of target temperatures begin to appear (largest excursion of 0.04 EC). Based on the small magnitude of these excursions, we propose to allocate the estimated temperature increases to all five dams. We are also soliciting public comment on alternative allocations, including limiting the allocation to three dams. Table 5-2, Column 3 shows temperature increases allowed at each target site as a result of dam operation at that site when the site potential temperature exceeds water quality criteria. The temperature increases in Table 5-2, Column 4 represent the total increase, based on the point sources and the dams, that can be caused by human activity within each reach and still meet the water quality standards at Columbia River Mile 42 when site potential temperature exceeds water quality criteria.

To determine the allowable increase in temperature due to dams during the time period when site potential temperature is less than water quality criteria (Nov 1 through February 5) RBM 10 was again run with the temperature increases from the five dams included. Because the allowable increase in temperature is higher during this time period, this simulation results in river temperatures slightly lower than the targets at RM 42. The model was run using trial-and-error to determine a uniform increase that could be allocated to each of the remaining 10 dams (0.12 EC).

Table 5-3 summarizes the gross wasteload allocations and load allocations using the information in Table 5-2 for the periods when (1) site potential temperature exceeds criteria and (2) site potential temperature is less than criteria.

This gross allocation of available heating capacity allows existing heat loads from point sources but requires reductions in heat load from dams. EPA believes this allocation scheme to be reasonable because of the relative temperature effects of point sources and dams. The analysis of NPDES point sources in the main stems indicates that the cumulative loading of temperature is deminimus in comparison to the effects of the dams and never in and of itself results in exceedance of water quality standards. Figure 5-3 illustrates this point. The red curve in the figure represents the existing temperature regime at river mile 42, the point in the river where point sources have the greatest cumulative impact. The black curve represents what the temperature would be if the point sources did not discharge heat. Even if this TMDL were to allocate the site potential temperature to each point source (ie., a wasteload equal to meeting water quality standards at the end of the discharge pipe), the applicable water quality standards would not be attained in the waterbody because of the temperature increases caused by the dams. Further, temperature reductions needed by the dams to achieve water quality standards would not change measurably. At the same time however, EPA recognizes that discharged heat may have local effects even at very small quantities, and as such, should be limited to the extent practicable. Taking these two considerations into account, this TMDL therefore provides a cumulative wasteload allocation applicable to all NPDES facilities in each reach that never exceeds 0.14 EC whenever site potential temperature is greater than the water quality criteria. That is, the cumulative effects of all the NPDES point sources is never measurable when the river exceeds water quality criteria. EPA believes that the wasteload allocations in this TMDL are reasonable in light of the following factors.

5. The NPDES point sources, in the aggregate, contribute less than 0.14 EC to the total temperature within each reach when temperature exceeds water quality criteria;

6. Limiting the point source discharges to site potential temperatures will have no measurable effect on water quality and reducing them beyond the levels contemplated by the cumulative wasteload allocation is not necessary to achieve water quality standards.

7. The majority of the temperature increases (as much as 6 EC) are cause by the larger dams: therefore, water quality standards cannot be achieved under Clean Water Act authorities, but rather need to be accomplished through federal, state, local and even, conceivably, international mechanisms.

Table 5-2: Increases in temperature at each target site when site potential temperature exceeds water quality criteria (July 1 - October 31)

(1) Target Sites	(2) Maximum Increase Due to Point Source Allocations (EC)	(3) Maximum Increase Due to Dam Allocation (EC)	(4) Total Increase Within Each Reach Due to All Allocations (EC)
Columbia River Sites			
Grand Coulee Dam	0.001	0.0	0.001
Chief Joseph Dam	0.001	0.0	0.001
Wells Dam	0.001	0.11	0.111
Rocky Reach Dam	0.0015	0.13	0.1315
Rock Island Dam	0.003	0.05	0.053
Wanapum Dam	0.001	0.0	0.001
Priest Rapids Dam	0.001	0.28	0.281
McNary Dam	0.052	0.0	0.052
John Day Dam	0.002	0.0	0.002
The Dalles Dam	0.0008	0.147	0.1478
Bonneville Dam	0.004	0.0	0.004
River Mile 112	0.02	0.0	0.02
River Mile 95	0.026	0.0	0.026
River Mile 72	0.026	0.0	0.026
River Mile 42	0.046	0.0	0.046
River Mile 4	0.001	0.0	0.001
Snake River Sites			
Snake River Mile 138	0.06	0.0	0.06
Lower Granite Dam	0.003	0.0	0.003
Little Goose Dam	0.003	0.0	0.003
Lower Monumental Dam	0.003	0.0	0.003
Ice Harbor Dam	0.003	0.0	0.003

Table 5-3: Gross wasteload allocations and load allocations at each target site

(1) Target Sites	(2) Gross WLA (EC)	(3) Gross LA (EC)		(4) Total Allocation (EC)	
Applicable Dates	**7/1 - 2/5**	**7/1 - 10/31**	**11/1 - 2/5**	**7/1 - 10/31**	**11/1 - 2/5**
Columbia River Sites					
Grand Coulee Dam	0.001	0.0	0.12	0.001	0.121
Chief Joseph Dam	0.001	0.0	0.12	0.001	0.121
Wells Dam	0.001	0.11	0.22	0.111	0.221
Rocky Reach Dam	0.0015	0.13	0.09	0.1315	0.0915
Rock Island Dam	0.003	0.05	0.07	0.053	0.073
Wanapum Dam	0.001	0.0	0.12	0.001	0.121
Priest Rapids Dam	0.001	0.28	0.18	0.281	0.181
McNary Dam	0.052	0.0	0.12	0.052	0.172
John Day Dam	0.002	0.0	0.12	0.002	0.122
The Dalles Dam	0.0008	0.147	0.11	0.1478	0.1108
Bonneville Dam	0.004	0.0	0.12	0.004	0.124
River Mile 112	0.02	0.0	0.0	0.02	0.02
River Mile 95	0.026	0.0	0.0	0.026	0.026
River Mile 72	0.026	0.0	0.0	0.026	0.026
River Mile 42	0.046	0.0	0.0	0.046	0.046
River Mile 4	0.001	0.0	0.0	0.001	0.001
Snake River Sites					
Snake River Mile 138	0.06	0.0	0.0	0.06	0.06
Lower Granite Dam	0.003	0.0	0.12	0.003	0.123
Little Goose Dam	0.003	0.0	0.12	0.003	0.123
Lower Monumental Dam	0.003	0.0	0.12	0.003	0.123
Ice Harbor Dam	0.003	0.0	0.12	0.003	0.123

5.6.2 Individual Wasteload Allocations

The gross WLAs in Table 5-3 are the allowable temperature increases at each target site allocated to point sources. Section 4.2 discussed the effects of point sources on water temperature and Figures 4-1 and 4-2 illustrated the increase in temperature that results from point sources at River Mile 42 where the impact of the point sources is greatest. Section 5.6.1 explained how the temperature increases resulting from point sources were calculated and Table 5-2 listed the temperature increases resulting from point sources at each Target Site. Those temperature increases are the same ones identified in Table 5-3 where they are the Gross WLA at each Target Site. Because point sources are discharging a heat load into the river, the individual WLAs discussed below are expressed as the daily maximum heat load in megawatts that each point source can discharge (see Equation 5-1). The combined point source loads (megawatts) within a target site reach result in the Gross WLA listed in Table 5-3.

Group Allocations and Individual Allocations

The existing point sources on the Columbia and Snake rivers range in size and effect on river temperature from very small domestic waste facilities with thermal loads as low as 0.01 MW (megawatts) to larger industrial facilities with loads as high as 540 MW. As was shown in Section 3, these facilities cumulatively do not increase water temperature by more than 0.14 EC, but some of the larger facilities do have substantial thermal loads.

To provide flexibility to the managers of these facilities and to the NPDES permitting authorities, small dischargers within each river reach are allocated a “group allocation”. That is, one load is allocated collectively to all the dischargers in the group.

To determine which point sources should be included in the groups, we established a threshold temperature effect. In this TMDL, the maximum increase in temperature over site potential, when site potential exceeds the water quality criterion, is 0.14 EC. This value comes from the Oregon water quality standards which define a measurable temperature increase as 0.14 EC or greater. We set the temperature effect threshold for small dischargers at 10% of this measurable increase or 0.014 EC. For the purposes of this TMDL, point sources that increase the cross sectional average water temperature by 0.014 EC or less are grouped by reach and given group allocations. This determination was based on temperature and flow limits in the permit, or if there were no limits, worst case discharges. In addition, point sources authorized to discharge under general NPDES permits are included in the group allocations. There are a total of 11 point sources addressed through individual allocations, 97 individual permittes addressed through group allocations and 136 general NPDES permittees addressed through the group allocations.

Maximum Discharge Levels

The WLAs for this TMDL have been established using current information on the reasonable worst case temperature and effluent discharge from each facility. However, as the WLAs consider the discharges' affect on the cross-sectional average temperature at the target sites and not local impacts, they represent the maximum discharge levels that the point sources could receive when their NPDES permits are re-issued. The actual permit limits may be lower than the loads established here for at least two reasons: adherence to State/Tribal mixing zone requirements and application of State/Federal/Tribal technology requirements. When NPDES permits are renewed, the permitting authority will evaluate each facility's compliance with mixing zone requirements and technology requirements. The effluent limits in the permit may be lower than those established in this TMDL as a result of those analyses.

Development of the Wasteload Allocations

There are 108 point sources with individual NPDES permits which have been considered in establishing this TMDL. Appendix C lists the point sources by river reach on the Columbia and Snake Rivers respectively. The appendix includes the existing thermal loads of each point source and the temperature and flow used to compute the load and indicates whether the facility will be part of a group allocation or receive an individual allocation.

The loads provided in Appendix C are computed in megawatts (equation 5-1). They are based on existing permit limits or reasonable worst case discharges from the facilities. That is, if the facility has permit limits for flow and temperature in its existing permit, they were used to calculate the load. If the facility does not have limits in its current permit, available monitoring data was evaluated to establish the highest load discharged by the facility under normal operating conditions. For some small dischargers for which there is no monitoring data conservative assumptions were used to establish the temperature used to compute load.

Equation 5-1: Point Source Heat Load in Megawatts

$$H = \Delta c_p Q T\ [1000\ l/m^3][1\ W/(1\ J/s)][1\ MW/10^6\ W]$$

H = heat load discharged in megawatts (MW)
Δ = density of water (1 kg/l)
C_p = Specific heat of water (4182 j/kg-EC)
Q = Flow rate (m^3/sec)
T = Temperature (EC)

Appendix C indicates that 11 of the facilities on the Columbia and Snake Rivers will be given individual wasteload allocations and 95 will be included in Group allocations. Ninety five of the 106 point sources caused an increase in cross sectional average temperature of 0.014 EC or less. The 11 point sources that have individual allocations cause more than 0.014 EC increase in the daily cross sectional average temperature, but the greatest of these in the Columbia River causes a 0.02 EC increase and in the Snake River a 0.06 EC increase.

Tables 5-4 and 5-5 summarize the point source loadings to the Columbia and Snake Rivers respectively. The tables provide the total allocation to the groups and the individual allocations and list the facilities receiving individual allocations.

Table 5-4: Summary of Group and Individual Wasteload Allocations for the Columbia River

River Reach/Facility	Group Allocations (maximum daily discharge)	Individual Allocations (maximum daily discharge)
International Border to Grand Coulee	**21.37 MW**	**0.0 MW**
Grand Coulee to Chief Joseph	**24.53 MW**	**0.0 MW**
Chief Joseph to Wells	**23.78 MW**	**0.0 MW**
Wells to Rocky Reach	**28.01 MW**	**0.0 MW**
Rocky Reach to Rock Island	**90.80 MW**	**0.0 MW**
Rock Island to Wanapum	**20.46 MW**	**0.0 MW**
Wanapum to Priest Rapids	**20.0 MW**	**0.0 MW**
Priest Rapids to McNary	**244.13 MW**	**875.5 MW**
Agrium Bowles Road		206.8 MW
Agrium Game Farm Road		384.5 MW
Boise Cascade Walulla		284.2 MW
McNary to John Day	**63.18 MW**	**0.0 MW**
John Day to The Dalles	**20.73 MW**	**0.0 MW**
The Dalles to Bonneville	**99.07 MW**	**0.0 MW**
Bonneville to River Mile 112	**164.04 MW**	**337.8 MW**
Fort James Camas		337.8 MW
River Mile 112 to River Mile 95	**926.3 MW**	**0.0 MW**
River Mile 95 to River Mile 72	**42.93**	**584.6 MW**
Boise/ St.Helens		219.56 MW
Coastal St. Helens		365.09 MW
River Mile 72 to River Mile 42	**235.85 MW**	**1302.54 MW**
Longview Fiber		455.4 MW
Weyerhouser Longview		545.43 MW
GP Wauna		301.71 MW
River Mile 42 to River Mile 4	**46.79 MW**	**0.0 MW**

River Mile 4 to River Mile 0	**26.28 MW**	**0.0 MW**

Table 5-5: Summary of Group and Individual Wasteload Allocations for the Snake River

River Reach/Facility	Group Allocations	Individual Allocations
Salmon River to River Mile 138	**30.28 MW**	**298.79**
Potlatch		298.79 MW
River Mile 138 to Lower Granite	**20.0 MW**	**0.0 MW**
Lower Granite to Little Goose	**20.02 MW**	**0.0 MW**
Little Goose to Lower Monumental	**21.39 MW**	**0.0 MW**
Lower Monumental to Ice Harbor	**20.004 MW**	**0.0 MW**

Ice Harbor to River Mile 0	**20.004 MW**	**0.0 MW**

General Permits

The National Pollutant Discharge Elimination System authorizes the issuance of general permits to cover the discharge of categories of dischargers (40 CFR 122.28). The general permit may be written to regulate storm water point sources or categories of point sources other than storm water if the sources in the category all:

1. involve the same or substantially similar operations;
2. discharge the same types of wastes;
3. require the same effluent limitations or operating conditions;
4. require the same or similar monitoring; and
5. in the opinion of the State Director or EPA Regional Administrator, are more appropriately controlled under a general permit than under individual permits.

Table 5-6 lists the general permits that have been issued in Idaho, Oregon and Washington that could potentially result in discharges to the mainstem of the Columbia or Snake Rivers within this TMDL area. The permits listed as issued by EPA are general permits for facilities in Idaho as well as federal facilities and facilities on Indian lands in all three states.

EPA does not expect the discharges allowed by the general permits listed in Table 5-6 to be a factor influencing temperature in the Columbia and Snake River mainstems. We believe that the contribution to temperature load from the sources covered by these general permits is minimal especially when compared to the temperature loads from the large individual permits and the impacts of the dams. Therefore, the wasteload allocations for the general permits are included in the group allocations. Under this TMDL, facilities can continue to be covered under the general permits and discharge as authorized by those permits. The nature of the facilities, the relative sizes of the discharges and the main stem, the seasonality of the discharges and the limitations and requirements in the permits all contribute to this finding. See Appendix D for more discussion of this finding. However, effluent monitoring for temperature should be included in all of the general permits so that the states can keep track of the loadings allowed to the river via the group allocations.

Management of the Group Allocations

The permitting authorities (EPA, ODEQ and Ecology) will have to develop a management plan to ensure that the groups don’t become over allocated in the future. They will have to keep track of heat loads authorized through individual and general NPDES permits. If a group allocation is reached, the permitting authorities will have to restrict further heat loads or combine groups in such a manner that will ensure that the distribution of heat load is maintained such that water quality standards are met at Columbia River mile 4. This will have to be a coordinated effort among the three permitting authorities. This management plan should be developed as part of the TMDL Implementation plan.

Table 5-6: General NPDES Permits

Agency	Permit Name and Number	Number of Facilities
EPA	Concentrated Animal Feeding Operation IDG010000	0
EPA	Aquaculture and On-site Fish Processors IDG130000	0
EPA	Stormwater Permits for Industries and Municipalities	21
EPA	Stormwater Permits for Construction	20 total/3 current
ODEQ	Cooling Water/Heat Pumps 0100	1
ODEQ	Filter Backwash 0200	0
ODEQ	Fish Hatcheries 0300	5
ODEQ	Log Ponds 0400	0
ODEQ	Boiler Blowdown 0500	0
ODEQ	Suction Dredges 0700	0
ODEQ	Seafood Processing 0900	6
ODEQ	Stormwater Permit for Gravel Mining 1200A	1
ODEQ	Construction that Disturbs Five or More Acres 1200C	5
ODEQ	Construction that Disturbs Five or More Acres - Government Agencies 1200CA	0
ODEQ	Construction Activities, 1200-C Permit Administered by DEQ Agents 1200CM	0
ODEQ	Industrial Stormwater 1200Z	21
ODEQ	Oily Stormwater Runoff, Oil/Water Separators 1300	1
ODEQ	Tanks Cleanup and Treatment of Groundwater 1500A	2
ODEQ	Washwater 1700A	0
ODEQ	Non Contact Geothermal 1900	0
Ecology	Boatyard General Permit	2
Ecology	Dairy General Permit	0
Ecology	Sand and Gravel General Permit	3
Ecology	Stormwater General Permits	
Ecology	Upland Fin Fish Hatching and Rearing	8
Ecology	Water Treatment Plant	3
Ecology	Fruit Packers	14

5.6.3 Load Allocations

Nonpoint Sources

While tributaries convey both point and nonpoint pollution to the Columbia and Snake River mainstems, they are treated as nonpoint sources of thermal energy in the context of this mainstem TMDL. There are 193 tributaries including seven significant irrigation return flows in the TMDL project area. Appendix E lists the 193 tributaries, their USGS Gauge Number, drainage area, average flow if available, whether or not they are on the 303(d) list for temperature, and whether or not they were part of the RBM 10 model. Note that thirty of the 193 tributaries are on the 303 (d) lists for temperature. There is no flow or temperature information available for many of the small tributaries, and as already described in section 4, very few of the tributaries are large enough to affect the cross sectional average water temperature in the mainstem. For these reasons, only the largest 25 tributaries are included as inputs in the RBM 10 model.

Generally, in TMDLs, the load allocation for tributaries is either the load needed to achieve WQS in the tributary or the load needed to achieve WQS in the main stem, whichever is more stringent. However, for this TMDL, the WQS for the mainstem and most of the tributaries are based on the site potential temperatures. Since, in most cases, the tributary loads that would occur if the tributaries were at site potential temperatures are not available, the site potential temperatures in the main stems have been estimated using existing tributary loads. The existing temperatures of the tributaries, particularly the 30 tributaries on the 303(d) lists, may be greater than their site potential temperatures, which would result in slightly higher heat loading than would be present under site potential conditions. But while the target temperatures of the mainstems may decrease a small amount due to future improvements in the tributaries, the temperature increase available for allocation to human activities in the mainstem will not change. Thus the tributary loads have been included as part of the background and are allocated their existing loads. Due to the lack of data on most of these tributaries and the fact that they have been incorporated into the background allocation, no numeric allocations have been explicitly developed for the tributaries. EPA anticipates that future tributary TMDLs will establish a lower heat load for many of the tributaries. Where that occurs, those loads apply. To date, temperature TMDLs have been completed for three tributaries to the Columbia and Snake river main stems: the Umatilla River, the Hood River and the Wind River.

Potential nonpoint source impacts directly to the main stems are insignificant or unquantifiable and thus not provided an allocation. Causes of nonpoint source impacts to water temperature are loss of shade, loss of temperature buffering from hyporheic and groundwater flows, runoff from agriculture, forestry and development along the rivers, and creation of impermeable surfaces in the watershed. Shade was not a major factor affecting temperature in the main stems because of the width of the rivers and their propensity to flood. Runoff directly to the main stems is minor during the warm part of the year when it would tend to affect water temperature, due to the precipitation patterns in the basin. The loss of hyporheic and groundwater in-flows resulting from the construction of the dams and impermeable surfaces has likely reduced temperature buffering in the main stems and the number and extent of cold water refugia. Given the size of the main stems the effect of the loss of these inflows is likely to be local and not sufficient to alter the cross sectional average temperature of the rivers. These effects are not quantified in this TMDL and not provided an allocation.

Dams

Dam structures are not required to have NPDES permits. However, dam facilities can include point sources, such as domestic waste discharges and cooling water discharges. These discharges do receive NPDES permits and are included in the WLAs in this TMDL. But the dam itself does not receive an NPDES permit to pass water through its turbines and spillway structures. So we are including the temperature allocations for dams as LAs and reserving WLAs only for those point sources that require an NPDES permit.

The LAs for the dams proposed in this TMDL is an increase over site potential temperature. However, the temperature increase over site potential is a difficult statistic to monitor in the field or to develop temperature improvement measures around. To make the TMDL more useful in planning and evaluating temperature improvement measures at the dams, we have provided two surrogate LAs, expressed in terms of target river temperature and the target temperature <u>difference</u> between target sites. These two surrogate measures, taken together, will allow for advanced planning to mitigate the temperature impacts of dams and for short and long term monitoring of the effectiveness of improvement measures in achieving the TMDL. The following is a discussion of each of these surrogate LAs.

1. Target River Temperature

The target temperature at a given site (and on a given calendar day) is the site potential river temperature plus the increase in temperature due to allocated heat inputs. When the target temperatures are reached at each target site, the loading capacity at RM 42 should be achieved.

Appendix B illustrates the target temperature at each target site graphically and includes the daily targets in tabular form. The graphs in Appendix B include the target temperature and the existing temperature, both as thirty year means. These target temperatures will not be useful in monitoring compliance during a specific year because they are means with considerable natural temperature variation around them. For example, there will be warm years during which the site potential temperature will be considerably higher than depicted in the graphs in Appendix B. However, the target temperatures are key metric for evaluation of TMDL implementation over the long term. As the TMDL is implemented, the long-term mean temperatures of the river at each site should approach the target temperatures depicted in Appendix B.

Since the target temperatures incorporate the effect of point sources, the difference between existing condition and the target temperature at a given site is a measure of the improvement needed at the dam(s) upstream of that site. While this is a straightforward approach to evaluating progress toward achieving the water quality standards throughout the

TMDL study area, it will be difficult to attribute excursions above the target temperatures to individual dams. With the exception of the target sites below the first dams in the study area, Grand Coulee and Lower Granite, the measured temperatures will be influenced by multiple upstream dams. The second surrogate measure is provided to address the need for analysis of improvements at individual dams.

2. Target Temperature Difference Between Sites

RBM 10 was used to determine the difference in temperature between all the successive dams when they are all achieving their TMDL LAs. Appendix G displays this information graphically and in tabular form as the 30 year means. There is considerable variation in the temperature difference between dams, even in the 30 year means. However, the temperature difference may be valuable in monitoring the effectiveness of implementation measures in the short term at specific dams. Scanning through Appendix G reveals that temperature differences between respective target sites is significantly altered by 5 of the dams: Grand Coulee, Lower Granite, Little Goose, Lower Monumental and Ice Harbor. With Grand Coulee Dam achieving its TMDL targets, the maximum temperature difference between the Canadian Border and the dam is about 1 EC and it occurs in the spring. Under current conditions, the maximum difference is over 6 EC and occurs in the fall. There is a similar relationship for the Snake River Dams. Under the TMDL, the maximum difference between successive target sites is generally less than 0.5 EC and occurs in the summer. Under current conditions, the maximum differences range from a 1 EC to 2 EC and occur in the fall. The short term effectiveness of implementation measures at these dams can be evaluated by comparing the temperature difference between successive target sites to the curves in Appendix G. While we would not expect exact matches because the curves in the appendix are for 30 year means, we would expect the data to emulate the patterns in the curves: that is, the relative magnitude of the differences and the timing of the curve. For example. If the maximum exceedances in the lower Snake River are in June and less than 0.5 EC, the implementation measures are probably effective. If the maximum exceedances are in October and over 1 EC, the measures are probably not effective.

5.7 Margin of Safety

Margins of safety can be explicit or implicit. Explicit margins of safety include:

1. setting numeric targets at more conservative levels than analytical results indicate;
2. adding a safety factor to pollutant loading estimates;
3. allocating a portion of the loading capacity to the margin of safety.

Implicit margins of safety include:

4. Conservative assumptions in derivation of temperature targets;
5. Conservative assumptions when developing the numeric model applications.

For this TMDL, explicit forms of a margin of safety pose the problem of forcing target temperature below the site potential temperature. Often in environmental analysis it is better to err on the conservative side because that offers greater protection in the face of analytical errors. In this case, however, that philosophy can result in desired improvements that are not possible to attain. Because of the importance of site potential temperatures in this TMDL it is important to err as little as possible on either side. That was one reason for using a one-dimensional rather than a two- or three- dimensional temperature model. With the data available or likely to be available in the near future, the cross sectional average temperature is more accurately simulated than the instantaneous temperatures throughout the depth and width of the water column.

Based on these considerations, there has been implicit margin of safety built into the TMDL. It is comprised of the following elements:

1. For point sources the wasteload allocation does not vary with flow. It achieves water quality standards at the 7Q10 low flow, thereby providing a margin of safety when flows are greater than the 7Q10.

2. As described earlier in Section 3.3, the use of daily average target temperatures is a conservative application of the WQS that addresses the effect of dams on diel temperature fluctuation.

5.8 Future Growth

Future growth has been allowed for in this TMDL through the allocation of 20 MW of heat energy to general permit sources/ future growth at each of the 21 Target Sites. Though 20 MW is a small amount of energy, it allows for considerable growth along the river. For comparison purposes, the City of Pasco sewage treatment plant is allocated 22.75 MW. Permitting authorities will have to develop a management plan to ensure that heat loads are not over-allocated in individual segments within the TMDL study area.

5.9 Monitoring Plan

Long term, system wide effectiveness of TMDL implementation activities can be assessed by monitoring mainstem river temperatures at the target sites. Over the long term, if implementation is adequate, the daily mean temperatures at the target site should approximate the 30 year mean target temperatures at those sites. Individual years may exceed those temperatures because of natural variation.

Short term monitoring for compliance with WLAs will be accomplished through effluent monitoring by the point sources. For individual dams, one option for short term monitoring is to evaluate the temperature difference between successive dams. The TMDL includes curves showing the temperature differences for existing conditions and for the conditions of the implemented TMDL. Effectiveness of TMDL implementation within individual impoundments can be determined by comparison of actual temperature differences between dams to the TMDL curves.

A temperature monitoring plan including clear, well defined objectives and a quality assurance/quality control component should be developed as part of the TMDL implementation plan. The objectives of the plan should include characterization of point source effluent temperature, and of daily average temperature at the target sites and in critical fish habitat and fish holding facilities in and around the dams.

In-river water temperature measurements should be collected in the fore bays of the dams but not right next to the dam structure. The monitoring site should be a sufficient distance from the structure to provide a representative estimate of daily average temperature of the forebay. Surface water temperature against the structure is likely to be influenced by the dam structure and not representative of the temperature regime of the river. A minimum design at these sites would include multiple temperature probes spaced between the surface and bottom of the river. In addition, single, continuous temperature monitoring sites should be located in tailraces, fish passage facilities, juvenile holding areas and other critical fish habitat near the dams.

6.0 Summary of the TMDL, WLAs and LAs

Table 6.1 summarizes the TMDL, the WLAs and the LAs for each river reach. The load available for allocation, as well as the gross WLA and the gross LA are prsented in bold for each river reach. The Group WLA, the individual WLAs and the individual LA follow the gross allocations for each reach. The Group and individual WLAs are given as megawatts. The LAs are given as the temperature increase in EC that the facility is allowed.

Table 6-1: Summary of the Columbia/Snake River TMDL, showing gross allocations for each river reach and individual wastload or load allocation for each facility in every reach

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
COLUMBIA RIVER FACILITIES					
International Border to Grand Coulee	**.001 EC**	**0.121 EC**	**0.001 EC**	**0.0 EC**	**0.12 EC**
Group			21.37 MW		
Grand Coulee Dam				0.0 EC	0.12 EC
Grand Coulee to Chief Joseph	**.001 EC**	**0.121 EC**	**0.001 EC**	**0.0 EC**	**0.12 EC**
Group			24.53 MW		
Chief Joseph Dam				0.0 EC	0.12 EC
Chief Joseph to Wells	**.111 EC**	**0.221 EC**	**0.001 EC**	**0.11 EC**	**0.22 EC**
Group			23.78 MW		
Wells Dam				0.11 EC	0.22 EC
Wells to Rocky Reach	**.1315 EC**	**0.0915 EC**	**0.0015 EC**	**0.13 EC**	**0.09 EC**
Group			28.01 MW		
Rocky Reach Dam				0.13 EC	0.09 EC
Rocky Reach to Rock Island	**0.053 EC**	**0.073 EC**	**0.003 EC**	**0.05 EC**	**0.07 EC**
Group			90.80 MW		
Rock Island Dam				0.05 EC	0.07 EC

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
Rock Island to Wanapum	**.001 EC**	**0.121 EC**	**0.001 EC**	**0.0 EC**	**0.12 EC**
Group			20.46 MW		
Wanapum Dam				0.0 EC	0.12 EC
Wanapum to Priest Rapids	**.281 EC**	**0.181 EC**	**0.001 EC**	**0.28 EC**	**0.18 EC**
Group			20.0 MW		
Priest Rapids Dam				0.28 EC	0.18 EC
Priest Rapids to McNary	**.052 EC**	**0.172 EC**	**0.052 EC**	**0.0 EC**	**0.12 EC**
Group			244.13 MW		
Agrium Bowles Road			206.8 MW		
Agrium Game Farm Road			384.5 MW		
Boise Cascade Walulla			284.2 MW		
McNary Dam				0.0 EC	0.12 EC
McNary to John Day	**0.002 EC**	**0.122 EC**	**0.002 EC**	**0.0 EC**	**0.12 EC**
Group			63.18 MW		
John Day Dam				0.0 EC	0.12 EC
John Day to The Dalles	**0.1478 EC**	**0.1108 EC**	**0.0008 EC**	**0.147 EC**	**0.11 EC**
Group			20.73 MW		
The Dalles Dam				0.147 EC	0.11 EC

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocations (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
The Dalles to Bonneville	**.004 EC**	**0.124 EC**	**0.004 EC**	**0.0 EC**	**0.12 EC**
Group			99.07 MW		
Bonneville Dam				0.0 EC	0.12 EC
Bonneville to River Mile 112	**.02 EC**	**0.02 EC**	**.02EC**	**0.0 EC**	**0.0 EC**
Group			164.04 MW		
Fort James Camas			337.8 MW		
River Mile 112 to River Mile 95	**0.026 EC**	**0.026 EC**	**.026 EC**	**0.0 EC**	**0.0 EC**
Group			926.3 MW		
River Mile 95 to River Mile 72	**0.026 EC**	**0.026 EC**	**0.026 EC**	**0.0 EC**	**0.0 EC**
Group			42.84 MW		
Boise/ St.Helens			219.56 MW		
Coastal St. Helens			365.09 MW		

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocations (Temperature Increase and Heat Loads)**	**Load Allocation (Temperature Increase)**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
River Mile 72 to River Mile 42	**0.046 EC**	**0.046 EC**	**0.046 EC**	**0.0 EC**	**0.0 EC**
Group			235.85 MW		
Longview Fiber			455.4 MW		
Weyerhouser Longview			545.43		
GP Wauna			301.71 MW		
River Mile 42 to River Mile 4	**0.001 EC**	**0.001 EC**	**0.001 EC**	**0.0 EC**	**0.0 EC**
Group			46.79		
River Mile 4 to River Mile 0	**0.001 EC**	**0.001 EC**	**0.001 EC**	**0.0 EC**	0.0 EC
Group			26.28		

River Reach / Facility	**Temperature Increase Allowed Within Each Reach**		**Wasteload Allocation**	**Load Allocation**	
	July 1 - Oct 31	**Nov 1 - Feb 5**	**July 1 - Feb 5**	**July 1 - Oct 31**	**Nov 1 - Feb 5**
SNAKE RIVER FACILITIES					
Salmon River to River Mile 138	**0.06 EC**	**0.06 EC**	**0.06 EC**	**0.0 EC**	**0.0 EC**
Group			**30.28 MW**		
Potlatch			298.79 MW		
River Mile 138 to Lower Granite	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			20.0 MW		
Lower Granite Dam				0.0 EC	0.12 EC
Lower Granite to Little Goose	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			20.02 MW		
Little Goose Dam				0.0 EC	0.12 EC
Little Goose to Lower Monumental	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			21.39 MW		
Lower Monumental Dam				0.0 EC	0.12 EC
Lower Monumental to Ice Harbor	**0.003 EC**	**0.123 EC**	**0.003 EC**	**0.0 EC**	**0.12 EC**
Group			20.004 MW		
Ice Harbor Dam				0.0 EC	0.12 EC
Ice Harbor to River Mile 0	**0.001 EC**	**0.001 EC**	**0.001 EC**	**0.0 EC**	**0.0 EC**
Group			20.004 MW		

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